HERBAGE REVIEWS

HERBAGE PUBLICATION SERIES

VOL. 7, No. 1.
MARCH, 1939.

I·A·B

PUBLISHED BY THE
IMPERIAL BUREAU OF PASTURES AND FORAGE CROPS
ABERYSTWYTH, GREAT BRITAIN

OUR CONTRIBUTORS

Mr. P. V. Cardon succeeded Dr. A. J. Pieters as principal Agronomist in Charge, Division of Forage Crops and Diseases, Bureau of Plant Industry, U.S. Dept. of Agriculture. He is chairman of the Joint Committee of Pasture Research of the American Society of Agronomy (*Herb. Rev.* 5. 63-64. 1937, and this issue, p. 40-41). Mr. Cardon was the head of the American delegation to the Fourth International Grassland Congress, Aberystwyth, 1937.

Oberlandwirtschaftsrat Dr. R. Geith is the Director of the Subsection for Land Cultivation in the Reichsbauernführers Office in Berlin. At the same time he is the Director of the Agronomical Research Station for Grassland Management at the University of Leipzig. His principal work has been concerned with the study of organization in connexion with grassland management. He has paid especial attention to the determination of pasture yield (see *Herb. Abstr.* 2. Suppl. 49-52. 1932; *Herb. Rev.* 1. 102-3. 1933; *Herb. Abstr.* 3. 184. 1933, 5.31 and 218. 1935, 8 Abs. 39 and Abs. 1094, 1938). In addition the author has been concerned with the study of various processes of haymaking. In addition to scientific work, the organization of forage crop production and the whole question of forage economics have received his attention. He has been Secretary and later General Secretary of the International Grassland Congress Association, centred in Leipzig, since its formation.

Prof. Enrico Pantanelli obtained the degree of Dr. Nat. Sc. from the University of Modena in 1902, of Dr. Chem. from the University of Rome in 1908. From 1906 to 1917 he held courses in plant physiology at the universities of Rome and Naples. From 1906 to 1912 he was assistant at the Station for Plant Pathology in Rome, from 1913 to 1914 he was sub-director of the Botanical Institute at Naples, and from 1914 to 1920 director of the Agricultural Experiment Station at Bari. Prof. Pantanelli first worked on plant physiology (assimilation, cell mechanics, enzymes, respiration, salt absorption), then on plant pathology (grape diseases, resistance factors, pathological physiology, effects of freezing, control of diseases and pests), then on agronomy (forage and oil plants, fertilizers, arboriculture, irrigation), and pedology (analytical contributions, agrological survey of Apulia and Lucania, alkali soils, organic matter, soil improvement, rock phosphate) and plant industry (oil-production from olives and several native products, alcohol-production from wild plants, sugar extraction from local resources).

IMPERIAL BUREAU OF PASTURES AND FORAGE CROPS

HERBAGE PUBLICATION SERIES

CORRESPONDING EDITORS

HERBAGE REVIEWS **Vol. 7. No. 1. March, 1939**

EDITOR: R. O. WHYTE

HERBAGE PUBLICATION SERIES

	Shillings per year.	Shillings per quarter
Herbage Abstracts, Vol. 9, 1939, and all available earlier volumes	25†	7
Herbage Reviews, Vol. 7, 1939, and all available earlier volumes	15*	4

†A reduction of 5s. will be given to subscribers resident in the countries of the British Commonwealth, and in Anglo-Egyptian Sudan.

*A reduction of 5s. will be given when *Herbage Abstracts* is also ordered.

No reduction can be allowed on subscriptions to the issue printed on one side of the paper only as from Vol. 9, 1939.

Correspondence regarding subscriptions or exchanges to be addressed to Deputy Director, Imperial Bureau of Pastures and Forage Crops, Aberystwyth, Great Britain.

Claims for Journals lost in Post will not be entertained more than three months after the date of posting the Journal

THE ORGANIZATION OF HERBAGE AND FORAGE CROP PRODUCTION IN GERMANY SINCE 1933

R. GEITH

Oberlandwirtschaftsrat, Dept. of the Reichsbauernführer, Berlin.

Chief Officer, Research Station for the Organization of Grassland Farming, University of Leipzig.

[Translator : G. M. ROSEVEARE]

Until 1933 it was characteristic of animal nutrition in Germany that a large part of the protein required for milk and meat production was imported from abroad in the form of concentrated feeding stuffs. With a total of

	Million	
	9.96	cows,
	7.00	young cattle,
	4.81	sheep,
	23.54	pigs,
and	3.44	horses,

the annual average import of concentrates for the six years preceding 1933 was approximately one and a half million tons. This importation meant on the one hand that Germany was, to a considerable degree, dependent upon foreign countries for its food production, a position which in times of international unrest could be, and has been, of critical importance. But it also meant reduced production in the forage crop areas of Germany itself, as interest in the production of home-grown fodder was not sufficiently great. Investigations have shown, however, that it is by no means advisable, from the viewpoint of animal health, to build up a nutritional system on the basis of foreign feeding stuffs, for home-grown products are of far greater value for the rearing of indigenous breeds.

The National Socialist agrarian policy, the object of which is to maintain an indigenous peasantry racially and economically sound and to promote their interests, was, therefore, necessarily bound to affect the organization of fodder production. Herein the first task was that of obtaining a better utilization of the existing grass-

land and forage crop areas, and of taking special measures to increase the quality and quantity of their output. The total agricultural area of Greater Germany amounts to 34.7 million hectares, of which a percentage of approximately 41 is occupied by forage crops and 33 by permanent grassland.

Million hectares	
3.35	permanent pastures
6.85	permanent meadow
1.-	**alpine pasture**
11.20	**permanent grassland**
2.-	clover and clover-grass
0.85	**lucerne**
2.85	**field forage crops**
1.-	catch crops

From the foregoing figures it is apparent that permanent grassland occupies the greater proportion of the forage area of Germany. On the basis of present research, the permanent grassland furnishes approximately 50 per cent of the protein available for animal nutrition. A further 20 per cent is furnished by the field forage plants, including catch crops, and 30 per cent is supplied by fodder cereals, pulse and roots. Nevertheless there is still a deficiency of protein, ranging—in accordance with weather and harvest conditions—from 0.6 to 1 million tons per annum.

In proportion to the share of the agricultural area occupied by permanent grassland, its contribution to the total yield is extraordinarily small, so that the permanent grasslands represent the chief reserves behind fodder production in Germany.

The following are the directions in which increased home production has been organized.

1. Extension of Silage Capacity

In view of the fact that considerable quantities of surplus forage were lost every year on account of poor weather conditions at harvest, the closest attention has been paid to the building of silos. From as early as 1933, every farmer who has built a silo has received a grant averaging RM.4.—per cubic metre silo space. Practical instructional courses in all parts of the country, wherein the various methods of safeguarding results by acidification, the adding of sugar, chopping, etc., are demonstrated, have greatly contributed to awaken interest in good ensilage practice and to promote the erection of silos. Since 1932 the number of silos has increased from 30,000 with a cubic metre capacity of 0.8 million to 320,000 with a cubic metre capacity of 6.7 million. Yearly exhibitions and the awarding of prizes in the different provinces, and the annual Reichsnährstand exhibitions for the whole of Germany, were found to have a specially encouraging influence. In short, there has been achieved with the silos and methods now available, practically without loss, and even under difficult conditions, the conservation of fodder with a high protein content.

2. Catch Crops

In connexion with the building of silos, special encouragement has been given to the growing of catch crops. Herein two main forms are distinguished:

(a) the winter catch crops such as rape, turnips, rye-vetch mixtures, wheat-vetch mixtures, crimson clover, ryegrass, vetch, etc., which, sown in August, give a harvest in May, when the fields are immediately sown again with potatoes, maize or other forage plants ;

(b) the summer catch crops such as clover mixtures, legume mixtures, sunflowers, maize, marrow stem kale and other fast-growing plants, which are sown after the harvesting of the principal crops, winter barley, rye, etc.

The increase in the area occupied by catch crops,

	Hectares
1927	352,412
1937	989,483

is a clear indication of the growing interest shown in this form of forage production.

3. Permanent Grassland

As the permanent grasslands constitute the main part of the area devoted to fodder production, but take a very low position in regard to productivity, their improvement is expected to furnish especially good results. At the present time, the German meadows produce an average of 4,000 to 4,500 kg. hay per hectare, and therewith 1,200 to 1,500 kg. starch equivalent or 150 to 250 kg. digestible protein. The productivity of the German pastures is not on an average notably higher, although the protein yield, under more or less rational management, rises to 300 to 400 kg. per hectare.

Research conducted at the various scientific institutes and co-ordinated in the Research Service (Forschungsdienst), the Reich organization for agricultural science, shows that it is possible to increase the productivity of the permanent grasslands to a quite extraordinary degree and continuously. With the exception of the mountain localities with their severe weather conditions and of the alpine grazings, it is perfectly possible to increase the yield of the German pastures to 2,500 to 3,000 kg. starch equivalent per hectare. In favourable localities yields of over 5,000 kg. starch equivalent with 1,000 to 1,200 kg. digestible protein per hectare have been obtained in long-duration experiments.

With a view to utilizing the reserves dormant in the permanent grassland, the following measures have been taken.

(a) Fencing and subdivision of meadows and pastures. Experience in Germany, as in other countries, invariably indicates that the yield of hayfields may easily be increased and rendered more reliable if they are continuously or intermittently grazed. Experience has also shown that intensive pasture management and increased yield are possible only when the pastures are subdivided into a sufficient number of small paddocks. For this reason the Reich Government gives every farmer a grant

of RM.80.- to 100.- per hectare of newly fenced-in pasture or pasture subdivided according to regulation. It is hereby required that the average size of the paddocks shall be such as to carry 800 to 1,200 kg. per hectare, or 16 to 20 cows. Since this measure was introduced, approximately 300,000 hectares have been newly fenced in or divided. Other advantages are also to be anticipated from the increased proportion of fenced land, for not only is productivity increased through correct grazing technique, but at the same time a saving of labour is effected and the farmer is, therefore, in a position to devote more attention to other crops.

(b) Systematic examination has shown that, of the 11.2 million hectares of permanent grassland, a not inconsiderable part is situated on land which—even with the most careful manurial and cultural treatment—could never produce optimal results. Considerably larger harvests could be obtained here from growing cereals and field forage crops. For this reason the Reich Government gives a subsidy of RM.80.- to 100.- for each hectare of unsuitable permanent grassland ploughed up, on condition that the ploughing is done according to regulation, that the area is properly sown with new crops and that thereby higher yields are obtained. Since 1937, when the measure was introduced, approximately 270,000 hectares have been ploughed up in this manner. It is aimed to achieve the ploughing up of between one and one and a half million hectares.

A special chapter in the promotion of protein production in Germany is occupied by the "sweet lupin." The Müncheberg Institute has succeeded in breeding a lupin free of bitter principle, which has been placed on the market as the yellow, blue, and white sweet lupin, (see R. von Sengbusch, *Herb. Rev.* 6. 64-71. 1938). With the wide extent occupied in Germany by light, sand soils, especially suitable for lupin growing, it has been possible to increase the lupin area to an extraordinary degree within a short time. From 1936 to 1937 it was increased from 25,000 to approximately 50,000 hectares. A gradual ousting of the bitter lupin from the greater part of the area is contemplated. The sweet lupin is equally suitable for green fodder and for ensilage and grain feed, and is, therefore, a universal fodder plant for the regions in question.

4. Field Forage Crops

Hitherto *Trifolium pratense* has been the most important field forage crop for a large part of Germany. In many districts, however, its cultivation is attended by risk on account of various diseases. For this reason there will be a further development of the present increasing tendency to replace red clover by lucerne in all districts of low rainfall, and in rainy regions to ensure better and safer yield by growing clover-grass mixtures.

5. Breeding

In the growing both of field forage crops and of catch crops a pre-eminent part is played by the use of high quality bred strains of grasses and legumes. Protein yield and the reliability of results can be greatly improved by this means. Through the regulation of prices a greatly increased interest in pedigree seed has been fostered,

and the breeding and reproduction of high quality herbage and forage plants have been encouraged.

6. Improved Harvest Technique

(a) In Germany the hay harvest represents the greater part of the fodder returns, as thirty-five to forty million tons of hay must be harvested yearly. In view of these great quantities, therefore, every improvement in technique is bound to have important results. As protein content is dependent mainly upon the time of cutting, and as this again depends upon the method of harvesting, by regulation of the time of cutting and by improving the method of harvesting, unusually high quantities of protein may be obtained. If, for example, the protein content of the hay harvest can be improved by one-half per cent only, it means an addition of 150 to 200 thousand tons of digestible protein to the total supplies of fodder in Germany. With this in view, for many years the closest attention has been paid to the use of suitable drying racks of the stake, hurdle, or wire fence type. In this case also practical courses in haymaking and exhibitions of high quality hay, co-ordinated with analyses made in the scientific institutes, are of principal service in disseminating an interest in frame-drying among farmers, an interest which has become very wide-spread in some provinces. To-day there are already provinces in which up to 60 per cent of the total hay harvest is dried on racks. While the hay hitherto harvested had an average protein content of 4 per cent, a protein content of 6 to 8 per cent and more has now been achieved by the proper use of drying frames. (See also *Herb. Rev.* 4. 82-93. 1936.)

(b) The artificial drying of forage plants is receiving especial encouragement from the Reich. Until recently it was principally protein-deficient material which was used for artificial drying as a by-product of sugar factories, but of late years the drying of plants rich in protein has increased to a very considerable degree. Of feeding stuffs with little protein—sugar beet wastage, cossettes etc.—from one to 1.2 million tons are produced annually at present. The production of dried protein material has increased within the last three years from 25,000 tons to 100,000 tons annually. There are now available 320 driers. Their number will be still further increased, as the Reich provides a subsidy of up to 50 per cent of the cost of instalment. Artificial drying can never be a substitute for hay curing, nor is it intended as such, for the costs of drying per fodder unit are in general too high. The object of employing the process for protein fodder is to produce a high quality protein concentrate and to preserve from loss valuable feeding stuffs which, on account of unfavourable climatic conditions, are difficult to harvest.

(c) An increasingly important part in the ensuring of productivity is being played by watering with fresh water and by the use of town effluents. Municipal and industrial works, as is known, withdraw from the land considerable quantities of water, which may have an unfortunate effect upon the water table of the soil, especially where industrial centres are crowded. It appears, therefore, to be of the utmost importance for the balancing of water relations that the refuse water from the towns should be returned to the land. In regions of low rainfall and light soils,

town effluents have proved extraordinarily valuable in their moistening and fertilizing action. In addition to roots and other field forage plants, permanent grassland plays a special part in the sewage-irrigated districts. The farmers who are members of an irrigation association not only have the right to use the water, but must also enter upon an undertaking to use it daily the whole year through ; so that only the possession of an adequate area of permanent grassland enables them to make uninterrupted use of the effluents. Large quantities of sewage water can be profitably employed on permanent pastures. Even from poor soils protein harvests of 1,000 to 1,200 kg. per hectare and approximately 4,500 kg. starch equivalent per hectare may be obtained through the use of effluents. This measure is receiving Government support. In general the town undertakes the carrying of the water to the agricultural district. Its distribution by means of irrigation canals and sprinklers is then carried out by the association, which is liable for all costs concerned therewith and for the cost of maintenance. The associations generally receive a State subsidy of 50 per cent.

To summarize : it is seen that the removal of protein deficiency is regarded as the foremost task of agriculture in Germany. The solution of the problem is being sought through the measures enumerated above. Noteworthy success has already been achieved in many directions. It culminates in the fact that—in spite of a reduction in the importing of protein feeding stuffs—it has been possible to increase the sum total of the animal products of Germany.

Average import of proteins per annum	Tons
up to 1933	1,500,000
up to 1937	480,000

In other words, Germany has succeeded in improving the productivity and quality of her grasslands and forage crop areas to such an extent that a considerably better utilization of her land has been achieved.

It is not only the measures taken by the Government that are to be thanked for this result, but first and foremost the willing co-operation of the German farmer, who is endeavouring, with exemplary zeal, to apply the discoveries of the scientist to his own farming practice and to utilize them for the increasing of production.

THE TREND TOWARDS A GRASSLAND AGRICULTURE IN THE UNITED STATES*

P. V. CARDON

Principal Agronomist in Charge, Division of Forage Crops and Diseases, Bureau of Plant Industry, United States Department of Agriculture.

THE TREND TOWARD A GRASSLAND AGRICULTURE

Destruction of grass has so long characterized land use in America, and the movement to restore grass† is so recent that it would be unjustifiable to state unqualifiedly that this country is adopting a grassland agriculture. It may never be practicable for America to adopt generally the grassland practices of Europe or New Zealand ; and there is reason to question the economic feasibility of adopting such practices in certain parts of this country. But that America during the last few years has launched and is supporting movements tending definitely in the direction of a grassland agriculture is plain to every observer. The more I learn of the historical development of grassland agriculture, the more I am disposed to feel that America is treading the same course as that followed by other countries a generation or more ago.

America to-day is definitely grass-minded. But America still lacks the profound grass-consciousness which prompts Europeans to take advantage of favourable physical conditions, to grow more and better grass, and to utilize it to better advantage.

Grass-consciousness differs from grass-mindedness. The one may be, and probably is, an outgrowth of the other, but grass-consciousness is the more profound. Grass-mindedness inspires grass culture for specific purposes, as, for example, a corrective of soil erosion. Grass-consciousness, on the other hand, regards such specific uses of grass as incidental to its primary uses. It is grass *itself* that is important—grass as a farm crop which is worthy of as good land and as intelligent culture as any other crop. Grass is a crop around which to build profitable farm enterprises ; it conserves the land, it benefits other crops grown in rotation with it ; it is the basis of a type of farming in which the control of erosion, the protection of watersheds and the improvement of pastures and ranges follow as matters of course. Thus, grass-consciousness recognizes and utilizes the intrinsic, greater value of grass without discounting, but automatically providing for, the full play of its incidental values. The culture of other crops fits into this grassland background and grassland agriculture emerges.

It is because America has not yet come fully to appreciate grass as a crop worthy of intensive cultivation and thoughtful management, that she must be regarded as only grass-minded. Speaking broadly, she still thinks of pastures as primarily

*The text of an address to the annual meeting of the American Society of Agronomy in Washington, D.C., November 16-18, 1938, which has been accepted for publication by the *J. Amer. Soc. Agron.*

†Grass, as used in this paper, refers to grass and legume mixtures as they commonly occur in pastures and meadows.

suited only to that land deemed too poor for other crops ; she still thinks of pasture improvement as related only to that land now in pasture, with little regard to the possibility of having better pastures on better land, where they might prove as profitable as most other crops ; she still thinks of grazing as merely a process of turning the livestock " out to grass " ; she still regards grass as a tool to be used in erosion control instead of regarding erosion control as a resultant of grass establishment and utilization for the value of the grass itself. True, here and there over the country, one finds exceptions to this rule—but they are exceptions.

But America's topsy-turvy thinking with respect to grass is, I believe, becoming a thing of the past. Having come to an appreciation of grass as a valuable resource, we are turning to methods of restoring grass on lands from which we earlier mistakenly ripped the sod. We sense now the value of grass in protecting us from the ravages of drought, wind and flood ; as a substitute crop on acres contributing to surpluses of corn, wheat and cotton ; and as a soil-building crop to replace soil-depleting crops. Moreover, we are experiencing in our efforts to restore grass serious difficulties which tend to make us all the more appreciative of grass cover once it is restored. By this route we shall pass in time from grass-mindedness into grass-consciousness.

This is a significant trend, likely to contribute notably towards a solution of current agricultural problems, but capable at the same time of creating new problems possibly as stubborn as some with which we now contend. That more and better grass has a place in American agriculture, I have no doubt. But whatever that place it will be determined in the long run by the extent to which it fits into economic farm practice. Grass culture induced by subsidy, under any program of soil conservation, may prove helpful in meeting emergency situations ; but grass culture, to be most helpful to American agriculture through the long years ahead, must be induced by an inner grass-consciousness on the part of farmers themselves.

That is the long view on grass. In holding it, I intend no under-valuation of current programs, each of which is exerting an influence conducive to wider use of grass in America. But I, for one, feel that all such programs would contribute even more if carried out according to a pattern acceptable to all groups affected by extended grass culture. Stated differently, I feel that what we are now doing with grass could be better done, if conceived and implemented in the light of an accepted grassland philosophy.

A Proposed Grassland Philosophy

That philosophy, however expressed, would take account of at least these assumptions :

1. That the ideal of soil conservation in America will become a fact when farm practice generally accepts and includes in cropping systems grass *as grass* and not as an expedient. For when American farmers become truly grass-conscious they will plant and manage grass in rotation with other crops because they appreciate its intrinsic values. Then, soil conservation, in all its aspects, will follow as a natural consequence.

2. Farmers will accord to grass its proper place in American agriculture when

they become convinced that grass culture is economically feasible not only as a dependable source of feed for livestock, but as a soil-improving crop to be reflected in the returns from other crops and as an otherwise legitimate component of cropping enterprises.

3. To this end, all research, educational, and action agencies could well afford to align their forces. In such alignment these forces would view grass culture broadly and with respect to its place in farm practice within wide areas. They would give full consideration to the economy of grass in current use, as well as to its value in preserving soil for future generations of society.

This alignment of forces probably could be effected as the result of joint thinking on objectives. I would look for constructive thinking among soil and crop specialists, but I would look confidently, also, to the animal husbandman, the nutritionist, the economist, the entomologist, and others. And I would look with equal confidence to organized local or regional groups, as county planning boards and conservation districts, from which would come both thought and action by farmers and business men alike. You see I am suggesting no new force, and nothing new with respect to the possible alignment of existing forces. I stress merely the need for a philosophy around which to effect the alignment.

By such procedure the more extensive use of grass in American agriculture would be considered not only from the standpoint of land use, which is of utmost importance, but also from the standpoint of grass used in livestock farming. Personally, I see in grassland agriculture no threat but instead a boon to the livestock industry. If there are misgivings, I think they may be viewed hopefully in the light of the experiences of other livestock countries. But in the formulation of grassland programs, potentialities with respect to the livestock industry should and would be fully considered.

Grassland agriculture represents a definite advance toward stabilized agriculture. It is not a reversion to pastoral practices. It cuts across all phases of agricultural production and, therefore, commands a high degree of managerial ability. It calls for all of the skill usually required in crop production plus the application of that and other skills in the production of crops in rotation with grass. The successful establishment and maintenance of a good grass cover require skilful application of the best agronomic information available ; and there is much still to be learned about the breaking and preparation of sod-land for succeeding crops in rotations of which grass is a part. Moreover, the utilization of grass, if it is to be made profitable, requires knowledge of a high order pertaining to animal production. A successful grassland farmer, in other words, must be a very good all-round farmer. That, perhaps, is reason enough for clarifying the major objectives of current grassing programs, for upon the farmer himself their ultimate value to America will depend.

My own feeling, as I have tried to make plain, is that whether we are ready to recognize it or not we are headed toward a grassland agriculture. With this in mind I would frankly adopt grassland agriculture as a worthy goal and seek the suggested alignment of forces to insure its achievement. In so doing, the true place of grass in erosion control, as in all other aspects of soil conservation, would be established.

REVIEWS

PRODUCTION OF FORAGE IN SOUTHERN ITALY

[Reviewer : R. O. Whyte]

[This review represents an abridged translation of Chapter 5 of the book by Enrico Pantanelli, on agronomic problems of the Bonifica in Southern Italy. (Problemi agronomici della bonifica nell' Italia meridionale. [Agronomic problems in land reclamation and improvement in Southern Italy.] *Bibl. Bonifica Integrale.* Vol. 10. Pt. 2. 1936). It is hoped that it will be possible to produce a companion review on the production of forage in Northern Italy, when the volume on the agronomic problems of that part of the country has been published.]

Even more difficult than the correction of soil deficiencies, which can be overcome with care, is the problem of selecting new crops which will justify themselves from an economic point of view. It is obvious that forage production is one of the first steps recommended in land improvement. Until recently the forages in Southern Italy were few and inferior in yield ; sheep and cattle were kept on rough pasture supplemented by straw, or rarely with leafy cuttings from olive trees or crushed field beans ; horses were fed on pasture, oats and straw, with a little addition of carob beans ; barley is still fed to pigs. Hay was hardly ever used, because of the cost of transporting it long distances.

In the last twenty years, however, the forage demonstration fields instituted by Agricultural Schools and Stations have shown that, in spite of the dry summer climate, it is possible to grow good forage crops in the south of Italy. An important source of forage are annual or seasonal forage crops which are still produced on too small a scale ; it is further possible to introduce perennial forage crops, this being considered as the greatest advance made in this section. Pastures, which still occupy a large area, can provide much higher yields if improved and properly managed ; finally, most valuable help can be provided by silage.

Forage Crops

The principal forage crops actually cultivated in the South are the " pasconi " or winter-spring crops which are harvested during April and May. These date from the Roman times. This type of culture is successful in the south as it profits from the winter rains ; it is a safe and reliable crop, capable of solving to a great extent the problem of providing forage. The thorough care of the winter-spring forage crops thus represents the first step which can and should be taken for the improvement of land in the south of Italy.

Forage crops should, if possible, be formed from soil-enriching leguminous plants, which also provide forage rich in protein and low in fibre. Leguminous winter forage crops may also be regarded as an excellent renovation culture suitable for increasing the soil fertility. The principal species used are as follows :

(1) *Vetch.* This crop provides a valuable hay although it is inferior to that made from lucerne. Black vetch is valuable in the warm zones along the coast, while white (rosy) vetch succeeds better in the cooler climate of the hills. The late-maturing species are to be avoided, for example, those which contaminate grain.

Vicia cracca and *V. villosa* are late maturing, but neither they nor *V. pannonica* are superior to local varieties of *V. sativa*. The breeding of vetch has been undertaken since 1935 by Prof. E. de Cillis at Portici and Dr. G. Conti at Bari.

Vetch cut at the end of April can yield 250 q. (quintals = 220 lb. = 100 Kg.) of fresh herbage per hectare ; 200 q. is the lower limit for a good crop. Vetch should be sown with oats, with which it can give 300 or even 400 q. of green forage, or 40 to 70 q. of hay per hectare. Combinations of vetch and rye are recommended for early cutting.

(2) *Small horse bean or favetta* (*Vicia faba minor*). This crop provides up to 400 q. of green forage, but cannot be made into hay. It is, however, equivalent or superior to vetch for making silage. For pit storage the small bean should be planted with oats, providing 400 to 600 q. of green fodder, while for green forage it should be planted with barley. The cutting of small bean may commence from the first days of March in order to provide early fresh stable fodder. There are many varieties of small bean, with larger or smaller seeds ; the varieties with small seed are preferred for the quality of their forage, and those with large seed for the quantity of forage. The green Turkish small bean is quite promising It is cold resistant, but is more affected by spring drought than the Italian bean.

(3) *Crimson clover* (*Trifolium incarnatum*). This is well known to agriculturists in the south and is widespread in Sicily, Calabria and throughout the Apennines, furnishing under good soil conditions an excellent forage which can also be made into hay. Several varieties varying in earliness may provide fodder from March through May. Crimson clover produces up to 250 q. of herbage and can be used as silage if grown with oats.

(4) *Berseem* (*Trifolium alexandrinum*). This species is suited to the hotter zones. If sown in September two cuts may be obtained, the first in February and the second in May or June ; it furnishes a total yield of 200 to 300 q. of green forage. Three cuttings may be obtained with irrigation, with a total yield of 500 to 700, or at the outside 1050 q. green forage. For the hot coastal areas berseem has the advantage of earliness, but is seriously affected by cold. In the Agricultural Station of Bari it has been regularly cultivated since 1921 ; it has also given excellent results in certain sandy soils. The herbage can be made into hay which is more palatable than any of the other legumes ; the second cutting of berseem is richer in protein, fat and salts than lucerne.

(5) *Fenugreek* (*Trigonella foenum-graecum*) produces at the most 150 q. of herbage ; it is recommended for soils very rich in lime, superficial and hot, and for late sowings between December and January. It produces a hay of bad quality, for which reason it should be fed green, when it provides an excellent fodder for draft animals ; it is not suitable for dairy cows or beef cattle because of the flavour which it gives to milk and meat. The related species, *Trigonella corniculata*, is more productive, but its growth is irregular and it is less palatable.

A good forage crop for high plateaux would be *Galega officinalis*. In certain localities lupins are also used for forage.

All these legumes differ in their soil requirements. *Trigonella* prefers thin calcareous soils, berseem and lupin soils which are low in lime, friable and fresh ; vetch prefers strong soils, the small bean moderately compact and clayey soils of the quaternary and more recent alluvial periods.

Winter crops are made with barley and oats and are well known in the south, especially in the feeding of horses. Barley may be cut from February onwards, oats when the tuft has scarcely completed its formation and when it contains the greatest nutritive value. Rye, if sown in September, can be cut from January onwards, or in some localities from mid-December ; this crop appears to give a

greater quantity of forage, but it actually produces less than the other crops. It is not possible to cultivate wheat after cereal forage crops in the ordinary rotation ; this is remedied by growing them on plots where they are followed by non-cereal crops ; they may also be cultivated on the ploughed stubble of perennial fields in order to remove the excess nitrogen. The high rate of production indicated in Table 1 may be obtained in soils of medium fertility and in purely Mediterranean climates, provided that certain rules elaborated by the agricultural research workers of southern Italy are followed.

Table 1.—Composition of the herbage produced by winter-spring forage crops (per 100 parts of fresh grass).

	Water	Protein	Fat	Cellulose	Extracts	Ash
Vetch	76.20	3.54	0.45	6.28	11.21	2.32
Small bean	71.50	2.28	0.40	7.66	15.31	2.85
Crimson clover	78.70	2.79	0.63	6.17	9.19	2.52
Berseem	75.00	4.41	1.00	5.30	11.75	2.54
Trigonella	73.50	3.29	1.41	8.63	11.22	1.95
Barley	71.50	1.66	0.62	9.48	15.41	1.33
Oats	73.10	1.99	0.70	8.22	14.04	1.95
Rye	69.70	1.74	0.45	10.60	16.35	1.16

The first working of the soil should be at a depth of at least 25 cm. as these cultures constitute the soil-improving crop in the rotation ; as they have to complete their growth in the spring they require a well-prepared soil without stagnant water. Superphosphate and manuring are applied, with lime added when necessary.

Vetch and small beans are sown in rows or in the furrow 25 to 30 cm. apart, thereby facilitating hoeing and the removal of inedible weeds. These forage crops are sown in the autumn, commencing with the clovers immediately after the first rain, then passing to the cereal-mixed crops, then to the small bean and finally to vetch or *Trigonella*. The sowing season thus extends from September to December.

The choice of time of cutting has a great influence on yield. Crops of clover and vetch may be cut twice in mild and wet winters. As late cutting reduces soil moisture it is advisable in the more arid areas to cut the crops before flowering, as the seed cultures, for example, vetch or small bean, consume a great deal more of the available moisture.

Grain crops are generally successful when following leguminous fodder crops, particularly when the latter have been properly manured. When the autumn-winter precipitation is not less than 400 mm., the fodder crop can enter the rotation as the equivalent of bare fallow land, thus contributing to the cultural and economic advantages inasmuch as it provides cattle fodder for stable feeding, which is thus a source of farmyard manure. The economic convenience of the forage crops is thus linked with the rearing of cattle for industrial purposes on the farms. With the production of green fodder at the rate per hectare of about 200 to 250 q., or of 30 to

40 q. of hay, and the straw from two hectares of cereals, it is possible to maintain a large number of cattle ; these fodder crop areas, therefore, represent a source of forage which will permit the organization of a proper animal husbandry.

Summer-Autumn Forage Crops

The introduction of summer or rather summer-autumn forage crops has been made possible by the application of dry farming methods. These crops may be cultivated in zones where the rainfall is at least 360 mm. from October 1 to March 31, 100 mm. from April 1 to May 31, and 90 mm. from June 1 to September 30, where the soil is at least 1 m. deep. The term summer crops is not to be used as, in the southern climate, production is scarce in the summer. They must, therefore, be called summer-autumn crops as good production occurs from September until the first frost.

In the valleys and less arid plains a few varieties of forage maize distinct from those cultivated in northern Italy pass the summer drought and give a good amount of green fodder in September. Certain varieties of maize have been selected from material from California, Mexico and Australia ; these varieties form a bushy head on five or even six stalks. The heads mature when the plant is still green, so that it can be utilized as forage after the heads have been gathered. The grains are hard, very rich in protein and more suitable for pigs and poultry than for human food. Where the rainfall is above 600 mm. and is more than 240 mm. from March 1 to August 31, maize may be cultivated for forage without irrigation, yields of up to 500 q. of green forage per hectare being obtained.

Sorghums are, however, the most valuable plants to serve as summer-autumn forage crops in southern Italy. Numerous species and subspecies are known, but those which give the highest forage yield belong to the subspecies *cernuum* and *dhurra* of *Sorghum vulgare* or *sativum*. The varieties which have given the best results for the production of grain forage in Puglia are *Kaoliang*, *Kafir*, *Darsò* (native of the Sudan) and sweet sorghum, also native of the Sudan. The varieties of *dhurra* or Milo and Feterita are more suited for grain production. Sorghums yield 50 to 200 q. per cut ; two cuts are usually possible without irrigation.

Sudan grass (*Sorghum exiguum* = *Andropogon sorghum* var. *Sudanensis*), which was imported from the Sudan into America in 1909 and subsequently into India and Australia, was introduced into Italy in 1920 and has since spread here and there throughout the country. It is a robust plant, valuable for forage because of its drought resistance. A first cut can be taken in June and a second after the summer dormancy in September. Contamination with *Sorghum halepense* is to be avoided. The sowing rates recommended are 16 to 20 kg. for broadcast sowing, or 5 to 6 kg. in furrows 35 to 70 cm. apart, according to the local rainfall. The first cut is necessary to prevent earing and drying up of the plant ; this provides 80 to 100 q. of forage. The second cut in September may produce 200 q. ; the third cut in October when the plant has fully eared gives 100 to 200 q. Sudan grass gives good results in dry areas over a great part of Southern and Central

Italy ; in the Po Valley it gives as much as four cuts with abundant yields. The crop may also be used for haymaking, the yield varying according to the time of cutting.

Of the leguminous summer-autumn forage crops only cowpea (*Vigna catjang*) has been found sufficiently drought resistant. From September to November it gives much forage, rich in protein, and tolerates repeated cuttings, while it also leaves the earth in a good condition for the succeeding grain crop. The crop is spreading over the Po Valley in Northern Italy as a second culture after an early cereal. A dry mixed summer forage crop is obtained by sowing sorghum with cowpea. Late varieties are preferable.

The soybean does not give sufficient yields in southern Italy without irrigation unless the summer rains reach 30 mm. per month. Above this rainfall the soybean produces even more than *Vigna catjang*. The soybean, however, may be useful even in semi-arid zones when sown mixed with Sudan grass or forage maize.

An essential condition for the success of these forage crops under dry farming conditions is the adoption of certain cultural practices which will ensure that all the autumn and winter precipitation is stored in the soil to benefit the crops during the following summer. None of the crops can be broadcast under dry farming conditions. They should be cultivated with summer hoeings, while the number of plants should be reduced in proportion to the June rainfall and kept low by cutting during the drier period from June until the end of August. They must never be pastured direct. After the final cutting maize and cowpea can be grazed, but sorghum may have toxic effects if grazed. Sudan grass is least dangerous in this respect and can be grazed 15 days after cutting.

The maximum forage productivity is obtained from these plants from September to November until the first frost. The forage can be utilized green, chopped up small, or else as silage. None of the crops are suitable for haymaking. The stalks of sorghum and particularly of sweet sorghum become richer in sugar as they proceed in development. They are, therefore, very palatable to cattle and sheep during the winter ; it is easy to preserve them dry in erect bunches in a sheltered place. Maize, cowpea and soybean are renovation crops covering the fallow land from April to October. Sorghum cannot be considered as a land-improving crop as it must be followed by a bean or a leguminous fodder crop, avoiding cereals. Other cultures do not succeed, not so much because the sorghum has consumed the soil nutrients as because of the reduced nitrification which occurs during the decomposition of sorghum roots, which are very rich in sugar and therefore favour the development of an abundant mycoflora.

Autumn-Winter Forage Crops

These have only a limited application in the South. Certain plants, however, can be useful, for example, white mustard and rye, which if sown immediately after the first autumn rain develop so rapidly as to provide a good first cut at the end of December or in January. This is possible where the first autumn rain falls in September, a normal event in some of the semi-arid parts. The rye gives 100 to 125 q.,

the mustard from 80 to 100 q. of green forage. With these crops it is possible to fill in part of the winter gap, but they are not so necessary if the farm has pasturage or perennial meadows.

Three forage crops with tuberous roots may be of importance in the South, namely, cow beet, rape and rutabaga. The first two are spring-summer cultures in the north of Italy, the first in particular constituting an important fodder for cattle-raising. In the semi-arid plains of Southern Italy these plants are profitable when sown in October after the first rains ; they thus become winter crops. In the more humid zones rape is beginning to be used as forage, sown with barley and other winter plants. These three cultures will find limited use, but the technical possibility of their culture is important and furthermore they provide an excellent forage for cows in calf.

The leaves of certain trees are used in the autumn and winter, for example, the olive, carob, almond, fig and prickly pear. The olive is already used considerably, the material being obtained from pruning between November and April ; it provides an excellent fodder, rich in albumen and fat and very palatable to animals. A suitable calculation is 1.5 kg. of fresh olive tree foliage per quintal liveweight. Olive foliage is also fed dry.

The prickly pear is used on occasions when forage is scarce, but it could be used more extensively in the hotter and more arid localities, especially in Sicily and Sardinia.

Experiments at Bari have further shown that four trees deserve cultivation in semi-arid zones in order that their foliage may be used as forage ; these are elm, mulberry, *Fraxinus ornus* and *Celtis australis*.

Perennial Meadows

In addition to sulla (*Hedysarum coronarium*), a perennial forage well known in Calabria and Sicily, experiments with ordinary cultivation and hoed cultivation have shown that there are also other leguminous perennial forage crops which can be cultivated economically without irrigation. An important result has been that even in southern Italy lucerne is the queen of forage crops, although until recently it has been regarded with diffidence by agriculturists in the south. Various objections were made against its cultivation. It was said that lucerne does not tolerate dryness ; that where the soil permits its cultivation it is possible to grow other crops which give a high yield ; that the lack of manure is an insurmountable obstacle to the production of lucerne ; and finally, that the short periods of the lease contracts (three to four years) do not permit the lessor to plant perennial crops. Furthermore, there is a widespread idea that lucerne itself has a harmful effect on animals and that horses cannot consume it. Of all these objections the only one which merits consideration is the short-term lease, a difficulty the solution of which is not the concern of the agriculturists.

Lucerne has given poor results in the semi-arid zones of the south because it has been cultivated in the usual manner. Instead it is necessary to apply to the

non-irrigated culture of lucerne the rules of "dry farming," that is, the crop should be cultivated as a hoed or weeded plant.

Lands suitable for this legume are not lacking in the south, although the depth of soil must necessarily increase with the duration of the ley and the length of the summer drought. For a six-year lucerne ley in a dry summer climate it is necessary to have a minimum of 2 m. of soil above the impervious subsoil. Lucerne succeeds equally well both in compact and loose soils, but prefers semi-compact soils with adequate or abundant lime and low alkalinity. In acid or even sub-acid soils the crop finds difficulty in absorbing calcium, forms few or no nodules and, therefore, does not fix the nitrogen of the air, but lives on the soil nitrogen and the manure. Even in sub-acid soils, however, nitrogen fixation may be obtained by the addition of lime. It is not only acidity, but also available calcium which act as limiting factors.

Soil cultivation on the lucerne plantation on compact soils should be carried to a depth of 30 to 35 cm. in any climate and should preferably be even deeper. In loose or semi-compact soils, for example, in alluvial plains and in lateritic red soils lucerne succeeds even if the depth of cultivation is only 25 cm. For long-duration leys it is necessary to depend more on the natural structure of the sub-soil than on the transitory looseness of the top-soil, which can always be obtained by cultivation. Ploughing is recommended in September and October, followed by manuring and one or more surface cultivations to keep the soil free from weeds at the time of sowing. Contrary to the general opinion, a scarcity or complete lack of farmyard manure at sowing-time, such as is inevitable in new farms with few stock, does not affect the establishment of the lucerne. The manure in fact acts more as a corrective of the structure than as a manure, hence its action is proportional to the compactness of the soil. At the same time, the manure introduces weeds and depresses the growth of the lucerne crop by tending to increase the acidity of the soil. In large-scale cultivation farmyard manure can be omitted without any effect on the lucerne crop. What is indispensable is the application of lime on calcium-deficient soils. In soils with at least 2 per cent of fine limestone it is sufficient to apply 10 q. of superphosphate per hectare to activate the nitrogen fixation of the crop.

The sowings should be done in rows or furrows in such a manner that 40 to 50 kg. of seed are scattered per hectare. In southern zones where the lucerne plantation is to be maintained for a number of years great care must be taken to keep it free from weeds from the very beginning. It is impossible to sow lucerne in a nurse crop of wheat or oats; this practice is gradually being abandoned even in the centre of Italy.

Many authorities advise autumnal sowing because of the fear of a spring drought, but lucerne sown in October suffers so severely from winter frosts that a great deal of the crop perishes during the winter. If sown, on the contrary, at the end of winter it is not affected by spring frosts. This unexpected behaviour is considered to be due to the poorer light of the shorter autumn days, as compared with the longer and sunnier days from February onwards, which permit the accumulation of sugar sufficient to provide resistance against low night temperatures. In countries further south, such as northern Africa and parts of Sicily, autumnal sowing may be prefer-

able as irrigation can be adopted, the winter light is greater and the frosts are rarer, but in the southern part of Italy better results are obtained from sowing at the end of winter, from the beginning of February to the middle of March, according to altitude.

The furrows should be 30 to 40 cm. apart, a distance which may appear large, but which experience has shown to be most suitable, as the distance between the furrows is inversely proportional to the spring-summer rainfall. Broadcast sowing provokes rapid thinning of the stand, due to rapid invasion by weeds which cannot be eradicated without great expense, and without damaging the lucerne itself. The northern varieties of lucerne are of little value for dry cultivation in the south, because they do not grow in winter and tend to vegetate more in summer; the southern varieties are more suitable because, like all southern plants, they continue to grow in the scanty light of winter and become more dormant during the summer droughts. A similar adaptation is obtained also within the ambit of varietal fluctuation; it is thus necessary to obtain seed from southern producers. The Bari Agricultural Station has grown a Molisan ecotype and a Benghazi variety which behave better than the Emilian lucernes. Cossack, Grimm, Turkestan and other northern varieties give very poor results in the South.

In the year of sowing it is necessary to cut the young lucerne between May and June, immediately after which it should be hoed by hand. In the first summer the lucerne should not be pastured or trodden down. At the end of October in the same year a first cut of lucerne may be obtained for green fodder and in the subsequent winter the meadow may already be lightly pastured with sheep until February, provided the soil is not water-logged.

At the conclusion of the grazing, which in subsequent years can be done freely with sheep, horses or cattle, it is recommended that the field should be cultivated every winter between the rows. Harrowing is not advised as it does not eradicate the weeds and damages the lucerne, reducing the yield of the first cut.

Manuring with superphosphate (5 to 6 q. per hectare) or sulphate of potash (2 q. per hectare) follows immediately, the two fertilizers being used alternately each year, this permitting a noticeable economy without reducing the total effect. Potash is more useful to adult lucerne than superphosphate because it favours leaf assimilation and the transference of nutrients from the leaves to the roots; potash can in fact be regarded as replacing farmyard manure in its manuring action.

During the summer no noxious weeds occur in the dry lucerne field; thus the drier the soil is in summer, the purer is the stand. For the same reason nitrogenous fertilizers are not recommended for long-duration lucerne leys. Lucerne which has received sufficient phosphate and lime does not need nitrogen.

In the hotter and less humid zones the growth of lucerne ceases during the summer from June to September, but is continuous through the winter; leys, therefore, offer good pasturage from the last autumn cutting until February. From the second year onwards it is even possible to graze lucerne from June to August.

The first cut in each year is made between April 15 and May 5, according to the altitude and is taken at the beginning of flowering for hay or at mid-flowering for

silage. A second cut is made in June. Silage is not advisable with lucerne alone as it decays readily because of the scarcity of carbohydrates ; it is recommended that it should be mixed with a fourth or a fifth part of chaffed straw or with green oats.

The summer cessation of growth may be absolute and the field then appears to be completely bare ; the lucerne disappears, but grows rapidly again in September and an abundant yield can be obtained from a cutting in October or November. The three cuts, of which the last is used as green fodder or silage, together with the herbage consumed by grazing, during the summer and the winter give a production of useful dry matter approximately equal to 100 q. per hectare per annum, which is obtained in the non-irrigated fields of Northern Italy. The differences occur in the arrangement of the periods of cutting and in the combination of grazing with cutting. In the North the autumn-winter production fails, in the South the summer production. These data refer to zones with an annual rainfall of at least 500 mm. ; where it is less, one may count on a spring cut, an autumn cut and winter grazing.

Mature lucerne fields also furnish a good quantity of high-grade seed, for the collection of which it is necessary to omít the summer grazing or even the June cut.

A lucerne ley cultivated in accordance with the above rules, which have been elaborated as a result of several years' experience at the Bari Agricultural Station, may last for fifteen years or more, whereas broadcast and non-weeded leys become thin and finally disappear in the course of 3 or 4 years. Breaking up and ploughing in of an adult lucerne ley increase the soil fertility during the subsequent 2 or 3 years, but it is impossible to re-introduce lucerne on the same soil until several years have elapsed.

Lucerne leys cannot be followed directly by grain, but by a seeded legume or other drill crop such as potatoes, cabbages and flax, or where it is possible, a summer culture such as maize, tobacco, tomatoes or French beans. In this case the ley is ploughed-in at the end of summer and the soil is kept well worked until the sowing of the next crop, the soil moisture being thereby restored. It is also possible to adopt after lucerne a rotation of oats and wheat without any manuring. For this autumn sowing, it is better to plough lucerne in June immediately after the second cut, or even before it.

The consumption of soil moisture by lucerne is much lower in Southern Italy than in countries with a dry winter and a wet summer, as the greater rainfall period coincides with lower temperature and lower evaporation. This consumption may be further reduced by cultivating the ley immediately after the autumn cut, but it is considered that this is already attained by pasturing, which reduces the transpiring organs to a minimum.

For all these reasons, therefore, the lucerne ley represents an essential improvement in dry-farmed estates. As the first year expenses are heavy the lucerne should be maintained as long as possible, at least for six years. This tends in the direction of increasing the capital of the farms in the form of cattle, of establishing a good husbandry with dairy herds and the intensification of sheep rearing, through the possibility of employing the lucerne herbage for a great part of the year, either in the form of cut forage or silage or grazing.

Lupinella or crocetta (esparsette, sainfoin, *Onobrychis sativa*) may prove suitable for shallow soils, which are even less than 1 m. deep, provided they are rather loose and rich in limestone. Lupinella is even less exacting than lucerne as regards organic manuring. In the hotter areas it may be sown in autumn, together with oats either broadcast or in drills 25 to 30 cm. apart. In colder areas it must be sown in February or March without another crop; it should, therefore, not be substituted for lucerne in places where the latter can thrive.

In the first year esparsette is cut in April or May with a yield of 300 q. of green matter or 60 q. of hay per hectare, after which the meadow remains reasonably pure. From May until the end of August it may be grazed. New growth begins in September and in October it gives another cut of between 80 and 100 q. of green forage; it may be then left for grazing until February. An application of superphosphate should be made and in the following May it provides another cut of 100 to 150 q., after which the ground is ploughed or the crop left for seed.

Thus lupinella may be introduced into the crop rotation after or before wheat, which can follow it even for two years; in the first year no manuring is necessary, while in the second a topdressing of nitrogen is sufficient. A number of estates in the South with loose and shallow soils have adopted this rotation with great advantage. The chief merit of lupinella is that it constitutes a ley on soils not suited to lucerne. It is also excellent for improving pastures. Lupinella is not suited for making hay, but can be fed to cattle as fresh herbage, hay or silage.

Sulla (*Hedysarum coronarium*) is the only forage plant which is well known in the South as being suitable for meadow cultivation. It is more drought resistant than lucerne, but not so persistent. It is found growing naturally on marly soils; it is widespread in Sicily and Calabria and is cultivated here and there in Lucania and Capitanate. Sulla is sown in the cereal crop in January or February, or on the stubble before burning. If higher yields are desired it is necessary to prepare the soil after stubble burning, by means of a good working in September and to sow in drills in October with a little oats. In colder localities the sowing must be delayed until February or March.

Sulla should be grazed until February to prevent it from becoming too tall. The May cut is most abundant, producing from 400 to 600 q. green fodder or 80 to 100 q. hay. Consequently, Sulla may be grazed until February and the first spring cut of the second year gives a further 200 q. of herbage. A Sulla meadow may be kept for three or four years, but this is not actually advisable beyond two years. It leaves abundant crop residues and its cultivation, especially in strong soils, is of great value for the subsequent cereal crop. In Calabria, Sulla is treated as a renovation plant and replaces the bare fallow in the ordinary three- or four-year rotations; admittedly its convenience is limited and doubtful in the second year, this explaining why, in soils which are not excessively clayey and arid, lucerne must be preferred. In actual fact, there is now a tendency to substitute lucerne for Sulla even on the clays of the Marches and of Tuscany, because of the lower cold resistance and the deficient quality of hay of Sulla. In any case Sulla, because of the excellent silage

which it provides and the abundance of its yield as pasture, is still called upon in the improvement of the more clayey and droughty soils.

Red clover (*Trifolium pratense*) which is common in upper and middle Italy may be of use even in the South. Sown in September after the first rain, preferably with rye or barley, it furnishes a good cut in March in the hotter zones, and if rains are sufficient another cut is obtained at the end of May. In colder zones it survives the summer and lives for two years. In any case in its first year it gives a good and abundant yield (200 to 300 q. green fodder) and may be substituted for crimson clover. After cutting, it leaves a pasturage suitable more for pigs than for cattle and sheep. This crop is indicated for the higher and fresher parts and is indeed already being cultivated in mountainous zones of Calabria. It may be introduced into the crop rotation as an annual rather than as a perennial crop.

Improvement of Pastures

In actual fact the production of fresh forage in extensive farms of the South is represented almost exclusively by pasture, which is generally to be found in a very poor state because of its long exploitation without manuring; phosphorus deficiency is particularly marked. Nitrogen is not deficient, the grassy spring pastures being rich in this substance. In certain pastures there is a deficiency of calcium and potash which may be due either to the fact that the subsoil is poor in them, or because long-continued exploitation has impoverished the topsoil.

According to the agricultural statistics the southern pastures are to-day not giving more than 3.5 q. per hectare, although the average figure may be rather higher than this; for mountain pastures it is probably 8 to 10 q. per hectare, calculated as hay. In the plains the production must be even greater as in certain areas the spring pastures support ten large cattle on an area equivalent to 24.7 hectares. Pantanelli considers that, allowing for the fact that the pastures are supplemented by an unlimited addition of straw, it may be assumed that the average yield of pastureland is 12 q. dry crop per hectare on the plains and 8 q. in the mountains.

The question of a possible increase of this production is then considered. The simplest system for improving pastures appears to be that of a year's rest or an annual rotation of the pasture, but experience has shown that the larger production in the year following that of rest is not sufficient to compensate for the total production of the two years of full exploitation. It is necessary, therefore, to adopt various practices for improving the pastures. This should begin with the removal of stones which may be used to construct the dry walls necessary to divide the pastures into paddocks for rotation; then follows the removal of unsuitable herbs and of prickly shrubs (wild pear, *Euphorbia*, *Spinosa*, *Ononis spinosa*, *Calycotome*, *Rhamnus*, thistles, etc.) in such a manner that leguminous plants may be sown in the spaces left by these plants. This system has been found particularly convenient, but it is recommended that care should be taken not to break the grassy sward which is regenerated only in the course of many years, even although its treatment has been carried out carefully. In place of the sward there may be an invasion of weeds of little or no feed value.

The sowing of leguminous plants is necessary because it is chiefly they that have suffered by the continuous exploitation, due to the removal of phosphorus and potash from the soil. Another reason for the disappearance of superior forage plants from pastures is that their flowering is suppressed ; hence the value of seasonal rotations or of delayed grazing. The deficiency of phosphorus may be counteracted by an application of superphosphate or rock phosphate, a practice which has a direct effect on the flora and particularly favours the development of legumes.

The choice of seeds for filling the gaps in the pasture should be made from common meadow plants, such as lucerne, lupinella, sulla and sweet clover ; it is recommended that wherever possible seed should be collected from wild leguminous plants.

Sowing trials of the Bari Station with native species have given positive results in improved pastures with *Ononis viscosa*; *Medicago lupulina, scutellata, orbicularis, rigidula, turbinata, arabica, truncatula, disciformis*; *Melilotus sulcata*; *Trifolium subterraneum, scabrum, angustifolium, incarnatum, pratense, ochroleucum, stellatum, vesiculosum, repens, agrarium*; *Anthyllis rubriflora, tetraphylla*; *Dorycnium hirsutum*; *Lotus ornithopodioides, corniculatus*; *Psoralea bituminosa*; *Astragalus hamosus*; *Scorpiurus subvillosa*; *Coronilla scorpioides*; *Hippocrepis unisiliquosa*; *Onobrychis caput-galli, cretica*; *Lathyrus aphaca, ochrus, cicera*; *Vicia hybrida, dasycarpa, bithynica, monantha, ervilia*; *Phalaris minor*; *Phleum tenue*; *Milium multiflorum*; *Avena barbata*; *Lolium rigidum.*

The increase in productivity which is obtained permits the grazing on winter pastures of one-quarter, or on more fertile soils one-third more animals than the average. It would thus be a mistake to break the grass sward at the very beginning of the improvement, if only because the present pastures lie on shallow soils, while quite a considerable increase in forage yield may be obtained economically by the practices described above. In deeper soils it is better to break up the sward, as these permit the intensive cultivation of cereals and forage crops.

Local Fodders

In zones devoted to the culture of olive trees, olive cakes deprived of seed fragments, a feed rich in fat and carbohydrates, but poor in protein, may be used. For this purpose the cake pulp should be fed mixed with bran or powdered horse beans. Beans and barley crushed or ground on the farm also furnish two excellent fodders, the first more particularly for cows, the second for pigs. In the arboricultural zones of the south other plants, such as carobs, dried figs, grape dregs, bergamot, cedar and lemon pulp, residues from the industry making extracts from these fruits, may contribute to the feeding of cattle. Tomatoes also give residues which may be utilized for fodder. It is calculated that about two million quintals of tomatoes in southern Italy are manufactured, the residues of which, after removal of the skins, amount to about 300,000 q. Table 2 indicates the average composition of these southern fodders.

Table 2.

	Humidity	Protein	Fat	Extracts	Cellulose	Ash
Olive cake	24.0	8.2	8.0	26.6	28.2	5.0
Ground bean	14.0	26.2	1.6	48.0	7.0	3.2
Ground barley	10.2	10.7	2.6	66.5	7.4	2.6
Bran	14.0	15.7	3.2	53.9	9.5	3.7
Powdered carob	12.2	6.0	1.4	70.7	7.5	2.2
Dried figs	21.1	4.8	5.0	59.4	7.4	2.3
Fresh grape dregs	54.2	6.6	4.5	20.8	12.4	1.5
Dreg powder	8.3	8.8	14.5	19.8	43.8	4.8
Citrus pulp	7.1	6.4	1.2	65.3	15.0	5.0
Tomato cake	10.1	28.1	11.6	41.2	5.0	4.0

Seasonal Use of Fodders

To summarize the preceding sections, it may be said that in a dry farming estate of the coastal zones it is possible to arrange for the following seasonal distribution in the use of the various fodders. On the winter pastures and perennial meadows—grazing up till February. From March to May—cutting of grass fodders and winter meadows. From June to October the production of fresh herbage is suspended in the drier localities, while in the less dry areas it is possible to have one or two more cuts, or some grazing. In September there begins in the less arid zones the production of summer-autumn grass fodders; in October the perennial meadows may be cut again everywhere; from November on, these and the winter pastures may be grazed.

Silage

For the feeding of dairy cattle during the summer months, it is necessary to use silage, which, contrary to the practice obtaining in the north, is of more value in the summer than in the winter in Southern Italy. In the semi-arid zones it solves the problem of keeping cattle on the estates throughout the year, and avoids transhumance, provided there is sufficient drinking water for the stock.

Various types of silo are used. As regards the material to be ensiled, in Southern Italy it is most convenient to use the winter-spring forage crops. Crimson clover is used alone or with oats or straw; small horse bean (favetta) is used similarly. Mixture with straw is not to be despised, as it gives this product an economic value. Vetch and lucerne also give excellent silage, being crushed with green oats or with oat or wheat straw. Finally, the summer crops, maize, sorghum, soybean and cow-pea, are all invaluable for silage. The graminaceous crops are packed alone, the legumes mixed with maize, sorghum or straw.

The section on silage is long and detailed, all questions relating to the process and to the nutritive value and palatability of the fodder being discussed for Southern Italian conditions. The final sections of the chapter under review deal with the special measures necessary for maintaining stock under these semi-arid conditions, for example, the provision of shelters from the sun, the advisability of stall feeding, etc. Even the "outcast" goat may find a place in a good husbandry, as it is the animal which best transforms the most varied forages and fodders into milk and meat.

THE COMPARATIVE NUTRITIVE VALUE AND RELATIVE COST OF FORAGE (PASTURE AND HAY) AND OTHER CROPS

[Reviewer : R. O. WHYTE]

AT the final meeting of the Fourth International Grassland Congress in Great Britain, 1937, a resolution was passed to set up working committees to determine the nutritional value and relative costs of grassland crops in comparison with other crops, particularly in the English-speaking countries. The objects are to advance grassland improvement by showing the high nutritional value and relatively low cost of pasture and early cut hay so that more attention is paid to the production and management of these crops, and, further, by developing methods of appraising crop production on a basis of feeding value and relative cost as in Scandinavia and Germany, where this rational, practical method has been developed to the advantage of agriculture. The Danish farmer thinks of, and plans his cropping system on, a basis of relative nutritive value and costs. The agricultural economist will also have a more accurate basis of crop accounting when the basis of nutritional value is clarified as a result of this work.

It was suggested by President Professor R. G. Stapledon that the "English-speaking countries put their house in order " in this respect and report their findings at the next International Congress in Holland. A letter dated October 15, 1938, from Dr. Geith (Berlin), states that provision has been made for this symposium in the programme of the Congress to be held in Holland in 1940.

Work on this problem is being initiated through the co-operation of the Imperial Bureau of Pastures and Forage Crops in other English-speaking countries, that is, Great Britain, South Africa, New Zealand and Australia.

In North America the first move to orient workers to this problem was to call a round-table conference of Canadian and American investigators in animal nutrition and crop production at the A.A.A.S. meeting on Ottawa, July, 1938. This Conference had the following terms of reference. "Comparative nutritive value of crops to bring out the comparison and advantages of pasture and hay compared with other crops in cost of digestible nutrients." The following papers were presented :

(1) Problems in evaluating pastures in relation to other crops. H. L. Ahlgren, G. Bohstedt and O. S. Aamodt, University of Wisconsin, Madison, Wis.

(2) Comparative cost of total digestible nutrients in pasture and other crops. E. S. Hopkins and P. O. Ripley, Central Experimental Farm, Ottawa, Ont.

(3) Seasonal variations in chemical composition of pasture hay and grain from different regions in Ontario. N. J. Thomas, Ontario Agricultural College, Guelph, Ont.

(4) Relative values of alfalfa hay and a mixture of concentrates for milking cows. T. E. Woodward, U.S. Bureau of Dairy Industry, Washington, D.C.

(5) Methods of evaluating live stock feeds. F. B. Morrison, Cornell University, Ithaca, N.Y.

(6) Remarks on evaluation of herbage and pasture. Paul E. Howe, U.S. Animal Nutrition Division, Washington, D.C.

(7) Some problems in the determination of the nutritive value of pasture herbage. E. W. Crampton, Macdonald College, Que.

Following the Ottawa meeting a resolution was passed recommending a second round-table discussion during the meeting of the American Society of Agronomy at Washington, in November, 1938. This was duly arranged under the chairmanship of P. V. Cardon, with the following objectives :

(1) Developing viewpoints with respect to (a) the desirability and (b) the practicability of compiling available information on the comparative nutritive value and relative cost of forage and other crops.

(2) Formulating a plan of joint procedure among interested groups, such as the American Society of Animal Production, the American Dairy Science Association, the American Society of Agronomy, and the Canadian Committee on Pasture and Hay.

(3) Initiating action that will make the plan of procedure effective.

Other contributions to this discussion were made by O. McConkey, who presented the report of the Ottawa Conference, F. B. Morrison (An animal production viewpoint), T. E. Woodward (Methods of evaluating pastures for dairy cattle), O. S. Aamodt (An agronomist's viewpoint) and R. D. Lewis (Some problems involved).

Abstracts or extracts from the last three contributions are given below.

T. W. Woodward, Bureau of Dairy Industry, U.S.D.A., Washington, D.C.

The evaluation of pastures is a complicated problem. The agronomist and the dairy or animal husbandman must work together, as the factors affecting the problem fail to lie completely within the sphere of activities of either. A number of methods that have been used are discussed and their shortcomings pointed out. The method used by the Bureau of Dairy Industry and some of the state experiment stations is described. In this method the effect of several of the interacting factors are measured as a whole rather than separately for the purpose of keeping investigations within the realm of practicability. The pastures are grazed by dairy cattle and the results expressed in terms of nutrients used per acre. In order to make economic comparisons the cost of the nutrients secured from pastures is weighed against the cost of nutrients in some feed or feeds of known market value which would bring about a similar production. A modification of this method based on correlation values of the yields from hand-harvested and grazed areas is suggested. If this modification proved practicable, pasture investigations could be greatly facilitated as much fewer animals and much less land would be required.

O. S. Aamodt, University of Wisconsin, Madison, Wis.

With a very limited amount of data available it has not been possible to arrive at any definite conclusions relative to the evaluation of various pasture crops. At this time one can only point out the problems involved in such a procedure and the need for, and desirability of, developing a satisfactory standardized technique for evaluating various types of pasture crops. It is evident from a survey of the literature and our own observations that the type of data needed is not sufficiently complete for general application in the United States. It would appear that a proper evaluation of the producing ability, relative cost, and feeding value of various pasture crops will serve directly in making for a greater efficiency in the use of pasture crops and increased interest in pasture improvement generally.

R. D. Lewis, Ohio State University, Columbus, Ohio.

A few specific suggestions as to studies:

(1) More definite information is needed concerning the ratio of *feed produced* to *feed utilized* on pastures, particularly on the so-called permanent pastures. How may the degree of utilization be increased where excesses occur? Without such basic information there is little justification for the interpretation of pasture improvement in terms of milk or beef, as if all of the herbage produced were actually consumed by livestock when available in a highly nutritious stage.

(2) There is need for developing a correlated system of keeping adequate records on selected farms that are being operated with complete forage programmes which include a maximum of usable pasture planned to provide quality and quantity herbage throughout the available pasture season. A careful analysis of such records will hasten the development of programmes of action—ones that are based on the satisfactory results obtained on actual farms. Needless to say, such record-keeping farmers will require much assistance from research and extension in planning and adjusting their programmes of crop production and utilization.

(3) Thus far our approaches in these United States to utilization of forage in conservation and improvement of land have originated from grain systems of farming. That is, we have considered what changes we might make in the grain system by substituting forage crops or by increasing the proportions of land in forage crops. We have had in this country no real approach from the viewpoint of " How little do we have to deviate from a forage system of farming ?" Farm-scale experiments which would utilize all the modern knowledge and techniques that are involved in maintaining and improving the productivity of our soils, and in furnishing feed largely through forage might upset or necessitate revision of some traditional ideas of crop production and nutrition of livestock.

As a result of this discussion, a proposed joint plan of attack was formulated by P. V. Cardon, as follows :

(1) Invite full participation through properly designated individuals or committees of the American Society of Animal Production, the American Dairy Science Association, the American Society of Agronomy, the Canadian Committee on Pasture and Hay.

(2) Organize a central committee (a) to direct action, (b) act as clearing house, and (c) prepare joint reports for approval by respective organizations.

(3) Secure approval by respective organizations of joint reports.

(4) Prepare joint reports for suitable publication and distribution.

This Bureau hopes to present the results of future action and discussion on this topic from time to time, and invites correspondence from the other English-speaking countries on the question as a whole, in order that a fruitful discussion can be held at the Fifth International Grassland Congress in Holland in 1940.

PHASIC DEVELOPMENT OF PLANTS (I)

A review recently prepared by the staff of the Imperial Bureau of Pastures and Forage Crops and published under the authorship of R. O. Whyte (*Biol. Rev.* 14. 51-87. 1939)* may be regarded as one of the first attempts in scientific literature to present not only a more or less complete account of the much discussed, but little understood, theory of phasic development, but also to co-ordinate it, if not to complete it, with that factual knowledge which has been obtained before and since the announcement of the principles of the theory some ten years ago, and which Lysenko and his immediate associates seem to under-estimate, if not to ignore altogether.

What is Vernalization?

No clear answer to this question is given in the present review; after a brief account of the history of vernalization, the review examines those fundamental principles upon which the theory and practice of vernalization have been based and advanced since 1928. If we endeavour to summarize all those concepts which together are known to us as "vernalization," and if we confine ourselves in the meantime to the ecologo-physiological aspects, we see that the subject covers (1) the theory of development (physiological readjustments leading to and terminated by sexual reproduction) which after a number of less successful alternatives appears in the Russian literature under the name of "stadiĭnoe razvitie," the English equivalent of which is "phasic development;" (2) the method of vernalization, that is, the method of "converting" winter or late forms into spring or earlier forms; and (3) the theory of the method of vernalization.

Therefore, the prime objective of the theory is sexual reproduction in all its aspects, an outlook which must surely take the theory far beyond the scope of a "chilling method" to which it has frequently been relegated. That much can be expected, as even the method of vernalization is directly concerned with sexual reproduction. But that is not all. Although the immediate cause of partial (as in herbaceous perennials) or complete (as in annuals) death of plants has not yet been ascertained, there is no doubt that reproduction is, as it were, the climax in the life of a plant, after which it sooner or later dies off. This has been ascertained in many experiments, in which the life of annual plants could be indefinitely prolonged when the advent of reproduction was prevented, either by removing the reproductive organs, or inhibiting the initiation or development of those organs by adjusting the environmental factors. It may safely be said that reproduction is the goal of plant life to which, perforce, all other vital functions seem to be subjugated or co-ordinated. Hence the other functions and aspects of plant life cannot and must not be investigated separately in time and space from that prime function of the plant to reproduce itself. In other words, Lysenko's theory, dealing with the regularities and nature of sexual reproduction, concerns not only the reproduction process, as such, but also all other co-participant and concomitant functions and hence, perforce, the entire life of the plant, that is, this theory concerns "the entire biology of plants." To take a concrete example, namely, carbon assimilation, which is apparently and admittedly so remote from sexual reproduction (pp. 79-80). Under the same conditions, CO_2 was less intensively assimilated in vernalized plants (more advanced in reproduction) than in unvernalized plants, and the rate of assimilation, while rapidly increased in the latter plants, remained practically unchanged in the former when day length was prolonged from 9 to 24 hours.

*The contents of this review will be dealt with in serial form in the four issues of *Herbage Reviews* for 1939.

History of Vernalization

Chronologically at least, the theory is an outcome of the ecological studies of the difference between winter and spring forms, and the possibility of "converting" winter (late) forms into spring (early) forms, a problem which has received much study during the last fifty years or so.

Maximov (*Herb. Publ. Ser. Bull.* 16) wrote that "although for the general public and even for scientific circles of agronomists, geneticists and plant breeders, who are not familar with physiological research, the idea of the possibility of 'transforming' winter plants into spring ones or late plants into early, etc. was altogether unexpected, nevertheless we are bound in justice to state that even before Lysenko's research a considerable body of experimental data had been accumulated in this field." Indeed, if we consult the literature it will be found that all the bases of modern plant physiology, including photoperiodism and vernalization, were known in agricultural science and practice in the past, long before they became the subject of modern study, but care must be taken not to over-rate this experience.

Having a rather vague idea of the subject, Martin (1934), while attempting to show that vernalization is nothing new, quotes a fairly long list of various methods of "chilling" and "warming" seeds, which, in his opinion, would suggest that "iarovization is not new as *the principles on which it is based* [our italics] have certainly been known for nearly a century and probably much longer"; he could trace them in fact as far back as Roman times.

Despite the apparent misconceptions, it can hardly be argued that agricultural practice has long been aware of the vital significance of temperature and light in the life of plants and many pre-scientific attempts were made to regulate growth and development to the advantage of mankind; nevertheless, owing to the lack of true understanding and the consequent primitiveness of the technique employed, all these empirical attempts failed to justify expectations and contributed nothing either to contemporary science or to practice; actually, out of many attempts made in the past only Gračev's experiments were, so to speak, continued by Maximov and his associates, but even in that case the attention to this attempt was most probably inspired by the results of Gassner (1918).

In short, we venture to consider that the works quoted *post factum* by Martin and also by McKinney and Sando, Maximov and Pojarkova, Ljubimenko and others, may be merely of "historical" interest, serving at best as a warning against lack of attention in following the experience of practice in the past and present.

Actually, the attempts at conscious regulation of plant life have been justly associated with the research of Klebs; it remained for Gassner to demonstrate the significance of temperature in the life of winter and spring plants and to attempt to convert winter forms into spring, and for Garner and Allard to demonstrate the role of relative length of day and night in the sexual reproduction of plants. It was upon this background primarily that Lysenko began his investigations.

Although Gassner (1918) seemed to anticipate great upheavals in science and practice in connexion with the possible "conversion" of winter forms into spring, no further work along this line was done by him, as far as we are aware, since 1918. If we admit that Lysenko continued Gassner's research, it is also necessary to admit that in doing so the *prima facie* principles of phasic development proved to be the turning point, and the final solution must be associated with Lysenko, who made an altogether unexpected approach to this problem, as well as to the whole life of annual plants in general. In his hands the method of chilling acquired an entirely different meaning, because of which the method was extended to many other annual and perennial herbaceous and even woody perennial plants. With certain reservations and perfections the chilling method may at its best be regarded as a "special case" of

vernalization, and, on the whole, one has to overlook and misunderstand a good deal to relegate vernalization to a "mere modification of Gassner's chilling method."

The Theory

The central point of Lysenko's research lies, however, not in the question of "conversion," but in the entirely new approach to the life of a plant. Although for investigators accustomed to studying minute details without any knowledge to which structure they belong, this theory sounds "too simple to be true," nevertheless it provides a bird's-eye view of the entire scheme of plant life, and its apparent simplicity has in reality complicated and yet elucidated many of the "simple" aspects of plant life and constitution, such as the vegetative period, winter hardiness, photosynthesis, mineral nutrition, etc. The importance of the theory is that for the first time it enables us to have a glimpse of the general laws and regularities and to connect hitherto disconnected and unrelated functions of a plant into a single dynamic complex process, that is, the life of a plant.

Growth and Development

The theory of phasic development consists of several inter-connected principles based upon experimental and circumstantial evidence. Among these, the master-key to the theory is the distinction between growth (changes in dimensions and weight of any organ) and development. By the latter is understood a series of certain, hitherto little studied, physiological readjustments in the plant or tissues of the embryo which, as they are attained, advance the plant towards the climax of its life, sexual reproduction. Growth and development appear independent of one another as a result of the response of plant organs to the environment, that is, as independent functions controlled on the one hand by the hereditary constitution of the plant and on the other by the environment. Lysenko seems to adopt a kind of conjunctive position between Pfeiffer's school, upholding the autonomy of plant life, and Klebs' school, maintaining the opposite view, namely, the subjection of the plant to the environment, the rhythm of plant life following upon the rhythm of the environment.

In studying the action of environmental factors, a discrimination must thus be made between their effect upon growth and upon development. How far this apparently self-evident statement is new in environmental studies may be judged from the historical paper of Garner and Allard (1920), who define the action of photoperiods on the "inhibition and initiation of reproduction" thus: "an illumination period on one side of the critical duration for flowering promotes certain forms of vegetative activity, while a light period lying on the other side of the critical promotes other forms of vegetative activity." The one form of vegetative activity is intended to be vegetative growth and the other form the advance of a plant to reproduction, that is, development or, in MacDougal's term, differentiation.

Yet the idea of discriminating between growth and development is not entirely new, many attempts to introduce such a discrimination having been made in the past, for example by Reinke (1901), Klebs (1903), MacDougal (1903), then Maximov (1925), Smith (1933), Ljubimenko (1934) to mention a few; but for some reason, only with Lysenko did this discrimination become practicable and indeed helpful in clearing up many doubtful points.

This outlook necessarily excludes any functional connexion between growth and development, both in the form usually ascribed to Klebs ("transition of vegetative growth to reproductive growth") and in the form advocated by Maximov ("antagonistic relation between growth and development"). By virtue of this principle, development is not only independent of the growth rate, but need not be concurrent

with nor subsequent to growth, although these two manifestations of plant life are usually interconnected. Moreover, being independent of size and age, that is, the time which has elapsed from seed germination, development may commence and progress in slowly-growing seeds as normally and rapidly as in a rapidly-growing plant. This apparently *post factum* extension of the principle may be regarded as the theoretical basis in the method of vernalization of germinating seeds.

All these perhaps fairly self-evident statements appear to have been based until recently upon circumstantial evidence, rather than upon factual knowledge. Lysenko himself did not provide any indisputable or direct proof and only now is definite evidence being obtained to show that the embryo can be vernalized, not only after or during germination but just as efficiently during seed ripening or in unripe seed without germination, when the growth of the embryo is practically nil.

In undertaking an examination of " the facts and principles upon which the theory and practice of vernalization have been based," it is necessary to provide factual illustrations, the more particularly so because of the inconsistencies which have appeared in connexion with vernalization, and, to some extent, with the development of plants, namely, cessation of growth during vernalization or vegetation leads invariably to cessation of development, as in tests of drought resistance reported by Udoljskaja (1936), or in tests of moisture and nutrients reported by Maljugin (1937). Yet cessation of vernalization or development does not, or may not, affect the growth rate. Therefore, apart from the appropriate environment, the prerequisites for vernalization include not only germination, but also maintenance of growth, that is, growth may be reduced to a minimum but not inhibited.

The reviewer attempts to compensate for this break by speaking of "a certain physiological state of the embryo at which the capacity to grow and develop is acquired," while cessation of development (vernalization) following cessation of growth is related to the assumption that the range of conditions maintaining growth is wider and includes the range of conditions maintaining development. That may be so, but, on the other hand, not every functioning tissue is capable of vernalization or development, even though the environmental conditions required are present (cf. the chapter in the review on localization and mechanism). Apparently the physiological ability to develop, that is, to acquire further physiological readjustments is lost with the age of the cells but in this " the present knowledge . . . is still too meagre for definite conclusions to be drawn."

But this is not the only break in the continuity of the theory. Lysenko states that development does not depend upon the size and age of a plant. Yet it is known that vernalization of seed of biennial plants (cabbage and beet) was either a complete failure or had little success, although vernalization of two to three month old seedlings under the same conditions was, at least, more successful. This cannot be explained merely by poor technique, since vernalization of one to two month old seedlings was less successful than that of three month old seedlings. This important aspect is not discussed in the review, although tentative suppositions can be made, of which the most probable is the following.

Despite Lysenko's statement, development begins not from seed germination but at least, as modern physiology teaches us, from the first mitosis and by the time the seeds ripen the tissues of the embryo have advanced in their development. Seed ripeness induces dormancy, that is a break in development ; after seed germination the embryo regains "a certain physiological capacity" to continue development. In the majority of plants hitherto studied, under ordinary conditions of cultivation the embryo succeeds in attaining that point in development after which the stage which Lysenko calls " the phase of vernalization" and the reviewer " the first phase" begins ; consequently, subsequent development is resumed from that stage and hence

it can be vernalized, as prescribed by Lysenko. Under special conditions, however, as in the extreme north where Kostjučenko and Zarubaĭlo (1935-1938) experimented with cereals, the embryo succeeds in completing the first phase as well before the advent of seed maturation ; consequently, vernalization of that seed, as prescribed by Lysenko, would be a failure. On the other hand, in some other plants under ordinary conditions of cultivation the embryo usually fails to reach that point of development after which the first phase begins, and dormancy interrupts development at a preceding stage ; consequently, vernalization would again fail, for the tissues of the embryo must first complete that preceding stage or stages and only then will be able to begin the first phase. It is quite possible that this is the cause of the failure reported in the vernalization of seeds of biennial plants, and more so, as in certain cases vernalization of seed was more or less successful.

Therefore, in vernalization of seed, as in any other studies, it is of the utmost importance to consider the previous history of the seed, as the life of a plant should be considered as consisting of pre-ripening development and after-sowing development, the boundary between which varies with the conditions of cultivation and, if vernalization is used, of pre-ripening development, vernalization and after-sowing development, with no rigid boundary separating these three component periods of plant life. There is no experimental evidence to support this view, but it is plausible, as the possible vernalization during seed ripening was reported in many plants such as cotton, cereals, peas, lupins, cabbage and beet in the extreme north (Kostjučenko and Zarubaĭlo, 1938).

The Plant and its Environment

Another principle of utmost importance in the theory is that sexual reproduction (development) is regarded as consisting of a continual series of étapes or phases, that is, a series of certain physiological readjustments ; these physiological phases occur in a strict rotation, that is, none of them can be omitted or repeated ; nor can a subsequent phase be initiated before the preceding phase has been fully completed. For the initiation and completion of a physiological phase definite conditions are required which have been shown to vary with plant forms and phases for the same plant. The completion of a physiological phase changes the environmental requirements of the plant for the further advance towards sexual reproduction, that is, physiological phases mark out more or less distinct ecological phases. In other words, during their lifetime plants require differing environmental conditions for advance towards sexual reproduction. It can be safely assumed that a change in the ecological phases signifies a change in the physiological phases, and inasmuch as the nature of the physiological phases is still unknown and difficult to detect, the change in the ecological phases is more conspicuous and has been investigated in many plants with a varying degree of accuracy before and since the announcement of Lysenko's principles.

In early environmental studies, however, the relation of a plant to an environmental factor, for instance the photoperiods, was studied at an independent self-contained episode in the life of a plant, little or no attention being given to its preceding and subsequent life-history. To illustrate this point we may refer to one of many experiments quoted in the review (p. 71). Unvernalized plants of winter wheat, that is, from seed grown at high temperatures, and vernalized plants, from seed subjected to "chilling" for a definite period, failed to head when grown in a ten-hour day, that is, in Garner's terminology (1933) they behaved as typical long-day plants ; when these plants were transferred to long photoperiods the vernalized plants headed rapidly, that is, behaved as long-day plants, whereas the unvernalized plants remained sterile and continued vegetative growth, that is, they behaved as

typical short-day plants. (It is now certain, however, to which of Garner's groups these plants should be referred).

Yet the wheat plants from seed ripened in a northern summer (Kostjučenko and Zarubaĭlo, 1935-1938) with or without vernalization headed rapidly in a long day, that is, they were long-day plants. Therefore, the previous history which affects their relation to photoperiods should be extended to the conditions of seed ripening. It is owing to this repeated disregard of the preceding and, as will be shown later, the subsequent history of the plant, that there has arisen an ever-increasing discrepancy of opinions in plant ecology, particularly in relation to temperature and daylight. This aspect of the theory, to which particular importance should be ascribed, will, however, be examined later in connexion with the vegetative period as it appears in the new conceptions.—M.A.O.

(References will be given in a later part of this review.)

A REVISION OF THE THEORY OF VERNALIZATION*

" In order to have a better grasp of what vernalization is, it is necessary to acquaint oneself with those scientific concepts upon which vernalization has been worked out." With these words Lysenko opens his booklet, published as the fourth edition in 20,000 copies, and then proceeds to a brief discussion of the *prima facie* principles of his theory underlying the method of vernalization in the terms and " factual bases " familiar since 1932.

No account of the theory is intended here, as its main outlines have been frequently discussed in varying detail and accuracy since its announcement ; nevertheless, it is appropriate to say once more that the theory rests upon three or four principles, of which perhaps the most important is the discrimination between growth and development, namely, that " *the development of a seed plant and growth* (that is, increase in weight, size and volume) *are not identical phenomena*." To support this conception, the author quotes " the parable " which has been repeated invariably since 1932, about the seeds " that fell by the way side," and " on good ground " ; the plants from those seeds are alleged to head and to ripen at the same time, despite marked differences in size and vigour. That such a behaviour pattern is far from being general and common is indicated by an experiment made some years ago at Aberystwyth ; wheat plants on poor soil and in small earthenware pots proved to be inferior not only in size and vigour to the plants on good soil and large pots, but also headed and ripened later and less profusely. If the well-established effect of fertilizers on growth and development be remembered, this behaviour pattern is surely more in line with every-day experience in science and practice. We do not doubt the soundness of Lysenko's diagnosis, nor have we any doubt that " *the size of plants in many cases does not yet give any idea as to the extent of development or the degree of maturation attained by the plants* " ; it may also be admitted that, as affected by the environment, growth and development may progress independently at different

*Lysenko, T. D. [Vernalization of agricultural plants ; with instructions for vernalization of wheat, barley and oats.] Fourth completed edition. 68 pp. with 12 text fig. Seljhozgiz, Moscow. 1936.

rates, but one might expect that in 1936 Lysenko should provide something more than circumstantial, if any, evidence in support of his views, the more so as there have been many experiments specially conducted to ascertain the validity of his principles ; e.g., those carried out in 1932-1934 with large sets of annual, biennial and perennial plants at the Institute of Plant Physiology of the Academy of Sciences, Moscow. In this respect, of particular importance is also the possibility of vernalization during seed ripening established by Kostjučenko and Zarubaĭlo with cereals in 1935, the results of which must surely be known to Lysenko.

We consider, therefore, that in the preparation of a revised and completed fourth edition, Lysenko could select less persuasive, but more convincing, arguments than " the parable of the sower " and thus avoid fallacies such as that found on page 10 announcing that " germination of seed is the beginning of plant development." This is, of course, not so—not only because modern plant physiology informs us (for example, the fifth Russian or second English edition of Maximov's textbook on " Plant physiology ") that " the life cycle . . . . begins with the primary division of the fertilized egg cell," nor because there is ample evidence that before the moment which Lysenko considers as the beginning of plant development " considerable development has of course occurred in the embryo " (Gregory, 1935), but chiefly because, as first shown by Kostjučenko and Zarubaĭlo (1933) and later by Gregory and Purvis (1936) and others, this " beginning of development " may be partially or fully attained by the embryo long before seed germination, and the latter is not indispensable for the completion of the stage of vernalization, as unripe seed may be vernalized without germination.

Another fundamental group of principles is that concerning phasic development, by which development is thought to consist of a series of physiological phases appearing in a strict rotation and endowed with distinct requirements as to environmental factors for their initiation and progress. These principles are also listed with much the same precision as the previous, although by 1936 ample evidence had been secured concerning the existence, at least in cereals, of four phases, namely, the alleged first phase or phase of vernalization (Lysenko, 1928-1932), the " transitional phase " (Mackov and others, 1936, Eremenko, 1936 and 1938), the second or photo-phase (Lysenko and others, 1932), and the third phase (gametogenesis), shown by Kraevoĭ and Kiričenko (1934), and Kiričenko and Bassarskaja (1935), but interpreted somewhat differently by Whyte (*Biol. Rev.* 14. 51-87. 1939).

Vernalization, that is, a method of inducing a physiologically potent embryo or plant to develop under specially arranged environmental conditions, rests upon the fact that " *it was experimentally established that appropriate qualitative changes in the cells of the growing point of the stem may occur irrespective of the size and age of the plant*," and that " *the changes specific to the stage of vernalization may progress as successfully in the growing point of the embryo* (which has hardly begun to germinate and has not yet pierced the seed coat) *as in the growing point of a green plant*."

Yet in the experiments of Kostjučenko and Zarubaĭlo (1935) under conditions, the potency of which was proved otherwise, vernalization of wheat seeds of northern reproductions was unsuccessful ; plants from the vernalized and unvernalized seeds headed at the same time, because the seeds from the northern reproductions were able, as distinct from those of southern reproductions, to complete (vernalize) that phase during seed ripening. Therefore, these principles required certain reservations even in 1936.

Furthermore, in many experiments with biennial plants in the period preceding the fourth edition, for instance Mihaĭlova, Edelstein, Česnokov and others with cabbage, and Krasiljnikov and others with beet, vernalization of seed was practically a complete failure whereas vernalization of seedlings, particularly two to three

month old plantules, was successful under the same conditions. Therefore, the statement that vernalization of that phase can be effected, irrespective of the size and age of the plant, requires considerable modification and revision.

Even in 1936 the theoretical basis of vernalization required reconsideration, but this was not done by the author, an omission which detracts much value from his discussion of the theory, a clear conception of which is indeed of the utmost importance for the practice of vernalization.

The immediate objective of vernalization is to force the embryo to complete, fully or partially, that part of development (chiefly the stage of vernalization) which after the usual method of sowing either cannot be attained at all, as in strong winter plants sown in the spring, or which is retarded, with the result that the plants either fail to produce seeds, or that the seeds ripen too late. In its after-effect, therefore, vernalization may be compared with a change in the time of sowing. Consequently, the efficacy of vernalization depends to a great extent on the after-sowing conditions. A warm vigorous spring will no longer be a retardative or inhibitory factor for vernalized wheat, as it is in the case of unvernalized plants ; it may speed up further development and on the whole be more beneficial than a cold prolonged spring, an aspect which must not be overlooked whenever vernalization is contemplated.

There is large scope for the application of vernalization. Not to speak of obtaining a larger number of generations (up to four) in a year, vernalization, while inducing no change in the genotype, may promote the fuller expression of certain properties and characters, or even manifestation of those which otherwise could not be expressed, that is, vernalization changes the phenotype. It also enables a more precise investigation to be made of the character of the developmental phases (lateness or earliness) with all the relevant corollaries, thus enabling a more conscious choice of basic plants to be made. For instance, two varieties may be equally late, one because the first phase is retarded and the other because the subsequent phase progresses too slowly, but their progeny may be early or even earlier than the earliest of the parents. In fact, if we refer to current biological research, vernalization would appear to be indispensable in certain investigations, such as the study of winter hardiness, and the success attained during recent years in the knowledge of plants can hardly be imagined without vernalization.

The aim of vernalization in agricultural practice is not to replace autumn sowings with spring sowings, but to obtain an earlier and better crop. The first attempt to test vernalization under farming conditions was made in the Ukraine in 1929 ; in the subsequent two years the technical details were studied by members of the Odessa Institute. As an agronomical method, vernalization appeared in 1932 when 43,000 hectares, of which 33,000 hectares were in the Ukraine, were sown with vernalized seed. In the subsequent years the area under vernalized sowings increased rapidly, being 200,000 hectares in 1933, 600,000 hectares in 1934, and 2,100,000 hectares in 1935. Judging from the replies to questionnaires, this four-year test on a large scale confirmed the advantage of vernalization and enables Lysenko in this booklet to form quite an optimistic conclusion, or at least more optimistic than that of Konstantinov (1937). It is quite possible that Lysenko has fuller and more reliable data than Konstantinov, but it is hardly possible to disagree with the latter's conclusions that the efficacy of the method, from an economic point of view, varied with the after-sowing conditions and hence with the time and place of sowing, particularly if we consider the rapid fall in winter hardiness in vernalized plants after sowing which has been established in many experiments, or the changes in resistance to fungous diseases as shown by Weideman (1936).

While talking of its practical application, the economics of the question must not be overlooked, as what may be expedient under larger socialistic conditions of

Soviet farming may or may not be advisable in countries with different economic conditions. Little, if any thing reliable, has been done in this respect outside the Soviet Union, but the information available, for example, R. Thomson referring to "Vernalization trials with wheat" (*N.Z.J. agric.* 55. 204-6. 1937), gives a rather unfavourable impression of what is, however, still quite an open question.

Despite its general title, the booklet is concerned chiefly with wheat and partly with other cereals. As is known, the technique of vernalization consists in that slowly growing seeds are transferred to the conditions required by the plant to initiate and complete the stage of vernalization and kept there for a time not shorter than that required by the embryo to attain, under particular conditions of temperature, moisture and aeration, those physiological readjustments which Lysenko identifies with that developmental phase. The temperature varies with varieties, being 0-2°C. for winter wheat and barley, 2-5°C. for hard late wheat, spring barley and oats, and 10-12°C. for soft spring and hard early wheat. The moisture also varies, generally being higher the lower the temperature required for vernalization. Thus to bring seeds to the required moisture, the following amounts of water should be given to 100 kg. air-dry seeds ; 37 kg. for winter forms (0-2°C.) ; 33kg. for late wheat (2-5°C.) ; 31 kg. for spring and early wheat (10-12°C.). The time required for vernalization varies, being 35 to 40 days for winter wheat, 10 to 14 days for mid-season wheat, and 5 to 7 days for early spring wheat.

Vernalization of large lots of seed, to which in fact the booklet is devoted, is rather difficult, and particular attention should be given during vernalization to the rate of seed growth, which is controlled by the moisture maintained in the seed. This moisture falls during vernalization and its fall below a critical limit may retard or even inhibit vernalization ; thus additional moisture (5 to 8 kg. water per 100 kg. seed) may be required. On the other hand, if moisture is excessive the seeds grow too rapidly and may make it necessary to discontinue vernalization before complete, and to sow the seeds under-vernalized early in the spring.

In conclusion, we may note another method of vernalization which appears as an outcome of the discovery of the possibility of vernalization occurring during seed ripening, namely, the vernalization of unripe seeds described by Zarubaĭlo (1938). The seeds thus vernalized can be ripened later and stored without any effect on their acquired property. Although this method cannot yet be applied on a large scale, investigators may find it much easier than vernalization of seeds after complete ripeness has been attained, that is, as prescribed by Lysenko.—M.A.O.

MANUAL OF PLANT BREEDING

A comprehensive publication* on plant breeding, incorporating the results of research to date, is to appear in approximately twenty parts, each of eighty pages, composing, when complete, five volumes. It comprises contributions from forty-one Continental scientists, and is edited by T. Roemer and W. Rudorf. The subject matter is distributed as follows. **Vol. 1**: general scientific aspects of plant breeding (nineteen contributions, of which an important proportion is due to the editors). **Vol. 2**: the breeding of the principal cereals (six contributions). **Vol. 3**: pulse, clovers and lucerne, grasses, forage kale. The following is the index to the separate contributions. Heyn (Heidelberg); peas, general. Hertzsch (Klein-Blumenau, Germany); field peas. Hackbarth and Troll (Müncheberg); lupins as grain legumes and forage plants. Mueller (Weihenstephan); vetch and horse beans. Rudorf (Müncheberg); clovers and lucerne. J. G. Knoll (Leipzig), Baur (Hohenheim) and Hertzsch (Klein-Blumenau); grasses. Lamprecht (Weibullsholm, Sweden); forage kale. **Vol. 4.** potatoes, beets, oil and fibre plants, tobacco (seven contributions). This volume includes contributions on beets, by F. Schneider of Klein-Wanzleben, Germany; on rape and turnips, by Baur; on lupins as oil plants, by Hackbarth and Troll (Müncheberg); and on soybeans, by Mrs. Herb-Mueller (at present at Bucharest). **Vol. 5**: vegetables, fruit, forest plants (sixteen contributions).

Up to the time of reviewing four parts have appeared, the first three comprising pp. 1-240 of Vol. 1, the fourth part presenting the first eighty pages of Vol. 4. Vol. 1 contains an introduction by the editors (pp. 1-7). F. von Wettstein (Berlin-Dahlem) writes on natural multiplicity of forms (pp. 8-45), wherein the genetical aspects of the subject and Vavilov's theory of gene centres are treated. Sixty-two references to the literature. T. Schmucker (Göttingen) deals with the biology of reproduction, with special reference to the higher plants (pp. 46-98). In addition to references to the general literature, there are 122 references to special literature. The Kaiser Wilhelm-Institut at Müncheberg contributes the next articles, namely, that on heredity by P. Michaelis (pp. 99-149; 174 references); that on chromosomes, sets of chromosomes, and polyploidy, by K. H. von Berg (pp. 150-77; 117 references); that on mutation, by E. Knapp (pp. 178-99; 42 references); and that on selection by W. Rudorf (p. 199 onwards). The last-named contribution is not yet complete. The pages which have appeared deal with natural selection (pp. 199-209; 77 references), and with the physiological aspects of plant development in relation to breeding (p. 210 onwards). The former part of the article devotes a considerable amount of attention to the subject in connexion with grasses, as in this Family the selective action of climate, soil, etc., has the greatest play and is least affected by human interference. The second section, still in course of publication, deals with the phasic development of plants, the importance of temperature and light and of other factors

*Roemer, T., and Rudorf, W. Handbuch der Pflanzenzüchtung. [Manual of plant breeding.] 29 × 20. Berlin: Paul Parey. 1938 onwards. RM. 6.50 per part of 80 pages. [Univ. Halle (T.R.), and Kaiser Wilhelm-Inst. f. Züchtungsforschung, Müncheberg, Mark (W.R.), Germany.]

in connexion therewith, vernalization, and the genetical bases of developmental physiology and their importance for plant breeding.

The first part of Vol. 4 contains the contribution by F. Schneider (Kleinwanzleben, Germany) on the breeding of *Beta*, as yet incomplete.

CONFERENCES

Swedish Seed Association

During Agricultural Week, at a special meeting of the above Association held on March 22, 1938, A. Müntzing delivered an address on results obtained in the Department of Genetics of the Swedish Seed Association, Svalöf, part of which is quoted below.

" From our own germinations we know that twin frequency in general is very low. It amounts as a rule to anything between 1 in 1,000 and 1 in 10,000. It is possible, however, without too great difficulty, to obtain a relatively large twin material. Subsequently the twins are investigated cytologically. To begin with we determined the chromosome number in all the twins, afterwards we introduced simplified methods. Thus of the two twin plants which grow from the same seed, as a rule the one, the so-called *b* plant, at first is much smaller and more feeble than the other twin. After it was found that most of the chromosome deviations are represented by these initially weak individuals, now in cereals only the *b* plants are examined in respect to chromosome number. Another considerable simplification of the work, used with all perennial material, is to allow the twins to grow up in the field and to select for chromosome determinations only twins of which the two components are different externally. Very often the twins are exactly alike and have then probably originated through splitting of one and the same embryo. Some of the twins, which are different from one another, have also been found to have deviating chromosome numbers. All the results obtained hitherto are brought together in Table 1.

" The data presented in the table confirm to begin with the Japanese results with wheat and also show further and above all that similar chromosome deviations can be obtained also in other species. The method is obviously general, although different species behave differently in regard to the capacity to form twins with deviating chromosome numbers. Among the deviations are triploid forms with 50 per cent higher chromosome numbers most commonly, next haploids,

Table 1.—Results obtained by the twin method.

Species	Number					Percentage plants with deviating chromosome number
	No. of twin plants	Triploids	Haploids	Tetraploids	Other deviations	
Triticum vulgare	366	17	—	—	—	5
,, *turgidum*	6	2	—	—	—	(33)
Secale cereale	221	2	—	1	—	1
Avena sativa	262	23	—	1	—	9
Hordeum vulgare	93	1	2	—	—	3
Phleum pratense	446	6	3	—	—	2
Dactylis glomerata	198	—	2	—	—	1
Festuca pratensis	34	1	—	—	—	3
,, *rubra*	32	1	—	—	—	3
,, *ovina*	6	—	—	—	—	0
Lolium perenne	105	4	—	—	—	4
Agrostis stol.	31	1	—	—	—	3
Cynosurus crist.	17	—	—	—	—	0
Poa pratensis	270	18	2	—	5	9
Trifolium pratense	3	—	—	—	—	0
Solanum tuberosum	4	—	1	—	—	(25)
TOTAL.	2094	76	10	2	5	4.44

while on the other hand tetraploids are very rare. The average percentage of chromosome-deviating twin plants amounts to 4.44, a value which, however, on account of the simplified methods must be regarded as a minimum value. It is still not known exactly how the twins are really formed, but it is very probable that, for example, the triploids arise through fertilization of the egg cells in the unreduced embryo sacs.

" These twin investigations appear to be very far removed from practical plant breeding work. I have, however, with timothy obtained results which show that this very special method of breeding can lead fairly directly to practically valuable products. As is seen from Table 1 we have had 6 timothy plants with 63 instead of 42 chromosomes. Three of these were produced recently, but the other three flowered as early as 1936. These plants were well developed and one of them in particular was distinctly more vigorous than the corresponding 42-chromosomed twin plant. The 63-chromosomed twins were found to have excellent fertility both on the male and female side. This is due to the reduction division being more regular than one would expect. The chromosomes bind one another in pairs and show so-called autosyndesis. This is connected with the fact that the chromosome sets in timothy are among themselves very similar. From the three plants we harvested quite a large amount of seed, both following crossing and isolation. The seed germinated the following spring and was used in a comparative trial with Gloria timothy as check (every tenth plant in the row). The trial was harvested and weighed last summer and the results are shown in Table 2.

" As small seedlings the high-chromosomed plants were striking owing to their vigorous manner of growth. The weighing trials show that this vigour is also characteristic of the full-grown plants. On the average the progenies of the 63-chromosomed mother plants had a 14 per cent higher weight than check, in spite of the fact that some progenies (numbers 2 and 4) were obtained after isolation and are therefore inbred. This difference is statistically certain. Some families are, however, distinctly better than the average. Number 3 for example has 22 per cent higher weight than the corresponding check. Further, it is seen from the relative numbers (check = 100) that the high-chromosomed plants are superior in weight wherever the number of individuals is sufficiently large to allow of comparison.

" It is worthy of note that such a result has been obtained so directly from the first 63-chromosomed twin plants. This leads one to expect still better results by the production of new

Table 2. Plant weight of progenies of 63-chromosomed timothy twins.

N : r	Weight 0	50	100	150	200	250	300	350	400 gr.	n	M±m	Relative value
1	4	30	50	43	25	17	7	1	—	177	165	106
standard	1	2	6	7	3	1	—	—	—	20	155	100
2	9	24	24	14	5	2	—	—	—	78	117	139
standard	3	4	3	1	—	—	—	—	—	11	84	100
3	17	96	190	163	86	27	5	1	—	585	152	122
standard	7	17	22	13	9	—	—	—	—	68	125	100
4	1	10	11	8	1	—	—	—	—	31	122	—
standard	—	2	2	—	—	—	—	—	—	4	(100)	—
5	48	104	159	102	29	8	2	—	—	452	124	107
standard	5	16	21	9	2	1	—	—	—	54	116	100
6	1	19	18	7	2	—	—	—	—	47	115	—
standard	—	1	3	—	—	—	1	—	—	5	(155)	—
Σ 1—6	80	283	452	337	148	54	14	2	—	1370	140.25 ±1.70	114
standard	16	42	57	30	14	2	1	—	—	162	123.15 ±4.64	100

63-chromosomed twins and by selection work among their descendants. To judge of the prospects of such work it is necessary first to study the variation in chromosome number in the progenies from 63-chromosomed mother plants. Hitherto, the chromosome number has been determined in 182 daughter plants of that kind and has been found to vary between 56 and 64. As not one single plant had a lower number than 56 it may perhaps be possible to produce an unlimited number of constant, octoploid timothy strains with 8×7 instead of 6×7 chromosomes. In the daughter plants examined as to chromosomes no absolutely certain correlation could be established between weight and chromosome number. The 56-chromosomed are, however, probably slightly better than those which have intermediate numbers between 56 and 63. The plants with the highest chromosome numbers (63 and 64) have also good weights. This supports the possibility of producing, with a starting point of 56-chromosomed plants, constant 84-chromosomed varieties through the twin method. If this figure has exceeded the optimum, one should be able to cross 56- and 84-chromosomed plants and in that way build up constant 70-chromosomed types.

" The twin method with timothy has thus already given interesting positive results, and further it has revealed a series of new possibilities for further work. The statement that the high-chromosomed timothy types are valuable, is certainly based up to the present only on one single weighing trial, but it is, however, very probable that these products will be of practical importance.

" *The American colchicine method.* We have been acquainted with this method for about six months. Up to the present we have conducted only a few preliminary experiments with colchicine, but we are now about to begin work on as large a scale as possible. Colchicine is a strong poison which even in very low concentration is able to destroy the cell divisions so that cells with double chromosome numbers originate. From these cells shoots with double chromosome numbers can arise. One treats dormant seeds or the growing points of seedlings. In both ways it appears to be relatively easy to produce polyploid forms. Positive results have been obtained with ten species. Obviously the colchicine method is a general method which either alone or together with the other methods will make it possible to produce polyploid forms in any plants."

Association of Scandinavian Agricultural Research Workers

The annual meeting of the Finnish Section of the above Association was held in Helsingfors on May 4, 1938, under the chairmanship of Professor T. Terho (*Nordisk Jordbrugsforskning* 20. No. 2-3A. 133-35. 1938). Two addresses were delivered, one by Professor O. Meurman entitled " New points of views in the sphere of plant improvement." He gave a summary of the development of chromosome research and described the possibilities now existing of producing new sorts of plants with doubled or multiple chromosome numbers and new desirable characters.

The second address, by Professor Y. Hukkinen, was entitled " Practical tasks of plant protection work." Besides research work, the plant protection departments of the Agricultural Experiment Institute carry on practical plant protection work on a comprehensive scale, which devolves on them as a result of the 1925 law concerning plant protection. These practical tasks have become so extensive that the lecturer considers it necessary to re-organize the work in question.

* * * * * *

The Joint Committee of Management of the above Association met during the Congress at Uppsala, and agreed to attempt to extend the work of the sections of the Association. The seventh Congress of the N.J.F. is to be held at Oslo in July, 1941. Meetings were held at Copenhagen from October 10 to 12 to make arrangements for the Congress, when it was unanimously agreed to simplify the agendas as much as possible so that more time could be devoted to discussions, and to extend the time devoted to sectional meetings by one day.—R.P.J.

American Society of Agronomy

The 31st annual meeting of the society was held at Washington, D.C., on November 16, 17 and 18, 1938; the attendance was about 700 (*J. Amer. Soc. Agron.* Vol. 30. No. 12. Decem

ber, 1938). Among committee reports, that concerned with the compilation of the bibliography of the more important contributions on the methodology and interpretation of results of field plot experiments supplies a list of 65 new titles.

The Joint Committee on Pasture Improvement during the last year has centred upon activities designed to bring about fuller consideration of the comparative nutritive value and relative cost of forage and other crops.

To this end, the Committee co-operated in the formulation of a programme devoted to this subject in connexion with the meetings of the American Association for the Advancement of Science held in Ottawa, Canada, last June.

As a result of that discussion it was deemed advisable to hold a round table discussion on the subject as a part of the programme of the American Society of Agronomy in Washington D.C., November 18. The purpose of this round table discussion was to consider the problems involved and to define a proposed procedure aimed at (a) the compilation of available data, and (b) at the clarification of the objectives of work remaining to be accomplished in this field. Discussion leaders represented the viewpoints of agronomists, animal and dairy production specialists, and extension workers. (See *Herb. Rev.* this issue p. 7.)

Abstracts of the following papers are on file in this Bureau.

T. M. Stevenson, Dominion Agrostologist, Division of Forage Plants, Central Experimental Farm, Ottawa, Canada. Strain building.

S. S. Atwood, Division of Forage Crops and Diseases, Bureau of Plant Industry, U.S.A. Self and cross sterility and fertility.

W. M. Myers, Division of Forage Crops and Diseases, Bureau of Plant Industry, U.S.A. Inbreeding and the utilization of inbred lines in the improvement of the naturally cross-pollinated forage plants.

F. W. Tinney, Bureau of Plant Industry and University of Wisconsin, Madison, Wisconsin. The development of the embryo sac and the origin of the embryo in *Poa pratensis* L.

G. W. Burton, Division of Forage Crops and Diseases, Bureau of Plant Industry, U.S. Dept. Agric. Seed production problems in southern forage plants.

Central Fodder and Grazing Committee, India

In pursuance of the recommendations of the first meeting of the Committee held in November, 1937, to obtain complete information regarding the fodder and grazing situation in India, the following three bibliographies and a note were prepared and circulated to the Committee for its consideration at its second meeting at New Delhi, on November 21, 1938.

(a) Bibliography dealing with the publications in India regarding (i) Indian grasses and grasslands and fodder trees, (ii) Cultivated fodders.

(b) Bibliography dealing with the published literature on feeding experiments on Indian cattle feeds (by Dr. K. C. Sen of the Animal Nutrition Section of the Imperial Veterinary Research Institute, Izatnagar).

(c) A bibliography prepared from Dr. R. McLagan Gorrie's card index on erosion.

(d) A note of an estimate of the amount of animal food available from all sources in India (prepared by the Assistant Agricultural Expert, Imperial Council of Agricultural Research).

It was decided that the bibliographies (a) and (b) be published in '*Agriculture and Livestock in India*' and their reprints should be available for distribution. Regarding bibliography (c), one part pertaining to Indian references was already in the press and would be available as a priced bulletin; the second part, containing references to foreign literature on the subject, has been compiled. This will not be printed but will be made available for consultation in the Library of the Imperial Council of Agricultural Research. The note at item (d) above was considered to be the first approximation on the subject; it was decided that the best course at the moment would be to take this note as a basis and circulate it to different provinces, asking them to fill in

the gaps. In order to obtain even approximately correct figures, figures for yield should be collected for at least five years.

2. The possibility of introducing cheap fencing in grazing areas, particularly a suitable live fence, was discussed. It was agreed that live fences must be something which a goat will not eat, and this ruled out at once all the *Acacia* species. The prickly pear was no longer available on account of the cochineal insect, and Agaves were too slow growing and were not very effective with the exception perhaps of the smallest Agave (*A. wightii*). The merits of *Euphorbia Roylenea* and *Euphorbia neriifolia* as live fences were discussed and it was agreed that these two Euphorbias were worth trying as live hedges in places where they were not yet used. It was also noted that these Euphorbias would not suit the water-logged areas. A member said that he had found a dry earth wall to be a very useful and efficient means of protection at Hissar, much cheaper than wire fencing. It was agreed that he should send a note with a photograph to the Imperial Council of Agricultural Research. The relative merits of a few other plants e.g. *Prosopis juliflora*, *Acacia Siamea*, the common Bamboo etc., as live hedges were discussed and it was agreed to recommend that experiments, which should include the cost of management, in the growing of these plants should be carried out wherever feasible.

3. *Reports from members of the Central Fodder and Grazing Committee who attended the International Grassland Conference, held at Aberystwyth in* 1937.

Messrs. Kumar and Bruen's reports had been considered at the previous meeting of the Committee and, therefore, only Messrs. Churchill and Wilson's reports were dealt with. Mr. Churchill had mentioned the necessity of finding suitable wild legumes and the Committee agreed that this point needed following up. In Mr. Wilson's report, a reference to the improvement of the fodder supply in grazing grounds both in quality and quantity through the medium of the animals themselves was discussed. Some members said that this work was already being done and a note by Sir Gerald Trevor mentioning improvement brought about by cattle in an enclosed area near Poona was referred to. It was agreed that this aspect of the question should be kept in view in Indian work.

4. *Scheme from the Government of Orissa for sand flora experiments on the sea beach at Puri.*

This scheme was discussed at length ; the opinion of most of the members was that the problem did not look like a sand binding problem and that before any work could be undertaken the problem required to be defined. It was agreed that the scheme should be referred back to the Orissa Government for further information, and to the Imperial Bureaux at Aberystwyth and Harpenden for suggestions.

5. *Consideration of the best method of harvesting and storing grass in heavy rainfall areas, e.g. Assam, Bombay (Konkan districts) etc.*

Experience in Bombay (Konkan) appears to indicate that the best way of dealing with the great surplus of grass during the early part of the monsoon is to make it into silage. Certain local associations do this successfully every year in large circular pits lined with bricks and concrete. The Committee agreed that the Imperial Council of Agricultural Research should obtain reports on this subject from different stations where the making of silage from grass is in progress and published the information in '*Agriculture and Livestock in India.*'

6. *Reports from Provincial Fodder and Grazing Committees.*

Provincial Fodder and Grazing Committees have now been set up in Madras, Bombay, United Provinces, Punjab, North West Frontier Province and Assam. Only two Committees, i.e. United Provinces and the Punjab, had sent up their reports for the information of the Central Committee. The Taungya system of work enunciated by the United Provinces Government and the attempts to apply this system which was complete by itself to new areas were appreciated. In those provinces where Fodder and Grazing Committees have not been set up so far, notes pertaining to the fodder and grazing situation were received from the Directors of Agriculture, Directors of Veterinary Services, and Conservators of Forests. Three such notes were received each from Bihar, Central Provinces and Sind. The note from Bihar had made a proposal to use canal banks for raising fodder grass. The Committee observed that the grazing in canal areas

might be a practical proposition in certain tracts, but ordinarily the work was not one likely to commend itself. The Central Provinces Report said that a certain amount of bunding (i.e. small embankment) work was being done by the Agricultural Department in catchment areas in conjuction with the Forest Department. The Committee remarked that this was quite a valuable piece of work and a note on the work would be welcomed for publication in one of the Journals of the Imperial Council of Agricultural Research, because precise information on this point was lacking.

7. *The collection of any results obtained by the introduction of controlled and rotational grazing.*

The Committee agreed that since the Fodder and Grazing Committees had now been constituted in various provinces, the results of investigations on controlled and rotational grazing might now be written up in the form of short articles and sent for publication in *Agriculture and Livestock in India*, the reprints of which could be distributed wherever required. It was also agreed that if data from outside India of possible application to Indian conditions were available, it might also be sent for publication.

8. *Simple methods of preventing or reducing 'erosion' in grazing areas.*

In this connexion a summary of the work done so far on contour-trenching in the hill sal forests at Bunniaburn, Kolhan division, in the Singbhum District of Bihar, together with the results so far obtained, was circulated to the Committee. The Committee expressed the desirability of conducting more experiments on contour-bunding and on contour-trenching to reduce run-off in grassland areas. A note on " Surface run-off and erosion on granitic mountain soils of Idaho as influenced by range cover, soil disturbance, slope and precipitation intensity" by George W. Craddock and C. Kenneth Pears of the Inter-Mountain Forest and Range Experiment Stations, U.S. Department of Agriculture, was brought to the notice of the Committee as a useful contribution on the subject, containing information which was likely to be applicable to Indian conditions.

[Report supplied by Dr. W. Burns, Imperial Council of Agricultural Research, New Delhi. Feb. 14, 1939. For earlier report see *Herb. Rev.* 6. No. 2. p. 122. 1938.]

American Association for the Advancement of Science

The report of the 103rd meeting of this association, held in Richmond, Virginia, from December 27-31, 1938, is published in *Science*, Vol. 89. No. 2301, February 3, 1939 ; the attendance was about 5,000. Summarized notes are given on sections A to Q.

Section G : Botanical Sciences. The address of the retiring vice-president and chairman for the section, Dr. F. E. Denny, of the Boyce Thompson Institute for Plant Research, was devoted to the history of the effect of ethylene on plants. Dr. A. F. Blakeslee discussed chemistry in relation to plant breeding, including the use of colchicine in the production of polyploids. Dr. W. J. Robbins described the role of thiamin (Vitamin B_1) in plant growth. Dr. I. W. Bailey described the microfibrillar and microcapillary structure of cell walls, with special reference to the nature and construction of the secondary wall in plant cells.

The Botanical Society of America held a number of meetings dealing with such topics as phases of sexuality and chromosome numbers in plants, morphology, and chloroplasts. The Physiological Section was held in co-operation with the American Society of Plant Physiologists ; with four regular sessions of the sections, one dealt chiefly with dormancy and germination (11 papers), another with water relations and translocation (13 papers), and the two remaining with growth-promoting substances (28 papers). A note on the proceedings of the American Society of Plant Physiologists is also given ; topics include chlorophyll and photosynthesis, response of plants to light, chemical composition, influence of low temperatures, etc.

Section O : Agriculture. The presidential address was entitled "The interrelation of soils, plant and animal nutrition." The section was chiefly concerned with horticulture and potato studies. (see *Herb. Rev.* Vol. 6, Nos. 1 and 3, 1938, for previous meetings).

Ecological Society of America

The twenty-fourth annual meeting of the above Society was held at Richmond, Virginia, on December 27 to 31, 1938. Among the papers read at the meeting were :—

Vegetation zones in North-eastern United States. F. E. Egler.

Observations on the possible origin of the "Balds" in the Southern Appalachians. W. H. Gates.

Plant succession on granite rock in Eastern North Carolina. H. J. Oosting and L. E. Anderson.

Native vegetation of the Southern Great Plains. C. J. Whitfield.

Major changes in grassland resulting from continued drought. J. E. Weaver.

Trends within the xerosere of the Nebraska sandhills during the past twenty years. R. J. Pool.

Soil moisture content of eroded soils as influenced by contour furrowing. M. L. Shubert and J. M. Aikman.

Chart quadrat computations. R. S. Campbell.

A floristic study of a developing plant community on Minnesota Point. Olga Lakela.

Extension of the field theory throughout the ecological sciences. Edward Haskell.

Report on the conference on plant and animal communities, held at Cold Spring Harbor. S. A. Cain.

The biological spectrum of Colorado Sand Hills. Francis Ramaley.

Subclimax prairie. W. E. Loomis and A. L. McComb.

Progress in the color photography of plants. P. L. Ricker.

Some contrasting features of the Chihuahuan and Sonoran Deserts. Forrest Shreve and T. D. Mallery.

An analysis of volunteer vegetation on fertilized soil. J. A. Small.

Development of vegetation on recent lava flows in Southern Idaho. W. A. Eggler.

Relation of latitude to the growth of timothy. M. W. Evans.

Abstracts will appear in *Herb. Abstr.* in due course. For previous meeting see *Herb. Rev.* 6. 46-7. 1938.

Fifth International Grassland Congress

The following amendments to the programme published in *Herbage Reviews*, Vol. 6. No. 4, Dec., 1938, should be noted.

The paper-reading sessions will be held from June 27 to July 2, and the tour of the Netherlands from July 3 to 9. After the tour through the Netherlands a visit (not more than 2 days) will be paid to some well known Belgian pasture lands.

Those who wish to present a paper are invited to send title and a short and clear summary as soon as possible, and not later than June 1, 1939, to the Secretariat in Bilthoven.

REVISED SECTIONS OF THE CONGRESS

(1) Soils, manuring.
(2) Genetics, breeding, seed production.
(3) Grassland sociology and ecology. Botanical analysis of grassland.
(4) Management and utilization of pastures. Farm organization questions.
(5) Fodder value of pastures. Fodder conservation.
(6) Establishment and management of sports grounds and airport landing grounds.

COSTS OF CONGRESS AND TOURS

Approximate costs of hotels, meals, transport, gratuities, not including the congress fee.

I. Sessions.

Reduced terms for congress members Fl. 6 and Fl. 5 per day. With private bathroom, Fl. 7.50. A small number at Fl. 4 is available. Includes room and three meals.

Extra for service and taxes, 13 per cent.

Excursions in the sessions period extra. The amount will be published later.

II. Excursion through the Netherlands.

From the morning of July 3 till the evening of July 9. Approximate cost of hotels, meals, transport, gratuities: Fl. 100.

ANNOTATIONS

Germany (43)

At the tenth anniversary celebration of the foundation of the genetical institute at Müncheberg, Germany, the title "Erwin Baur-Institut" was added to the present title (Kaiser Wilhelm-Institut für Züchtungsforschung), in honour of the Institute's first Director, the late Erwin Baur.—G.M.R.

Denmark (489)

Agricultural Societies for Crop Cultivation on Lolland-Falster

The report on the work of the above Societies for 1938 includes three main sections: I. Abed Crop Cultivation Station. II. Local trials and other crop cultivation activities. Summary of results of experiments in 1938 : Experiments and investigations with chemicals for the control of plant diseases and weeds. III. Report from the Lolland-Falster Grassland Society, 1938 : Report on experiments with different seeds mixtures. Report on variety and strain trials, including forage roots.—R.P.J.

Palestine (569.4)

Soil erosion and conservation

The following is a quotation from *Agricultural Supplement* No. 37 *to the Palestine Gazette* for the month of January, 1939.

In the *Agricultural Supplement to the Palestine Gazette* for the month of September, 1938, attention was drawn to the havoc wrought in Palestine by soil erosion and an extract on the subject from a Jamaican agricultural journal was quoted. The need for attention to this problem in Palestine is of vital importance as every square metre of suitable land in rural areas is required for the cultivation of crops or livestock to supply the growing population. If Palestine is ever to become anything like self-supporting in the supply of staple food-stuffs the soil on every piece of cultivated land must be jealously guarded against the depredations caused by wind and rain. Already considerable areas of land, particularly in the hills, have been rendered almost worthless by that arch-enemy of unprotected soil—erosion. It is not too late, even now, to save a good many of the hilly areas from destruction and it is even possible by careful farming to build up the soil

again on denuded areas and gradually to increase the depth and fertility of the soil so that it will produce heavier crops than in the past. The Department of Forests on several small areas has shown the effect of protecting the natural vegetation, which prevents erosion and collects valuable soil on bare slopes. On agricultural land, improved methods of terracing and cultivation are necessary, and unless the owners and occupiers in the hills take this matter seriously, and act so as to stop soil wastage, the time will come when they will have so little soil on their land that it will not be worth cultivating. All concerned must realise that the situation is serious and becoming more serious every year.

The Government Departments concerned are anxious to do all they can to teach land-owners and cultivators how to conserve their soil, and how to build up the fertility of what still remains on their land. The Department of Agriculture is ready to advise on improved methods of terracing and cultivation to conserve and improve agricultural soil. The Department of Forests is willing to suggest practical ways of managing uncultivated land so that the best results may be obtained without further loss of soil.

In an attempt to form public opinion, and to exchange views and information, a system of Soil Erosion Observers has been instituted, each member sending in to the Conservator of Forests an account of any flood damage, soil erosion, or anti-erosion measures, which may come to his notice. These reports are circulated to all members, and comments invited. New observers in Palestine are welcomed.

In this and the two succeeding issues of the *Agricultural Supplement* lectures on soil erosion written by the Director of Development, Trans-Jordan, are to be published, with the kind permission of the Trans-Jordan Government. (See *Agricultural Supplement* No. 38 *to the Palestine Gazette* for the month of February, 1939. p. 28.)

Basutoland (686.1)

Visit of L. H. Collett to U.S.A.

In 1937, Mr. L. H. Collett, Agriculture and Soil Erosion Officer, Department of Agriculture, Basutoland, visited the United States, with the aid of the funds granted by the Trustees of the Carnegie Corporation. A detailed report has been prepared; this, however, is not to be published, but will remain on the files of the Colonial Office, London. Mr. Collett left England on the Aquitania on August 11, 1937, and sailed from New York at the end of his tour on October 27. During that period, he was in the care of the Soil Conservation Service and the Forest Service of the U.S. Department of Agriculture, to whom he renders sincere thanks for the great assistance they gave him.

The report describes visits to Soil Conservation Experiment Stations, hydrologic, soil and water studies, flood control experiments, and nurseries. A special section is devoted to the Tennessee Valley Authority, others to range management research on the San Joaquin Experimental Range, and on the Indian Reservations and Demonstration Areas. Conservation practices discussed in detail include level terraces, contour furrows, graded terraces, terrace outlets and meadow strips, gully control and reclamation, strip cropping, and terrace or contour irrigation. Special attention was paid to the work in the South-western States, in which the conditions and problems were considered to be somewhat similar to those experienced in Basutoland (see *Herb. Rev.* 6. 280-9. 1938).—R.O.W.

U.S.A. (73)

Retirement of Dr. A. J. Pieters

On December 1, Adrian J. Pieters, Principal Agronomist in the Section of Agronomy and Range Management, Soil Conservation Service, U.S. Dept. Agric., retired from Government service, after his second executive extension had expired.

A graduate of the University of Michigan, Dr. Pieters did graduate work at Cornell University and at the University of Heidelberg, and received his doctorate from Michigan in 1915. Except for a 9-year interval spent in study, college teaching, and commercial seed-growing, he has been with the U.S. Department of Agriculture since 1895.

While making a study of the causes of clover failure for the Department, Dr. Pieters became convinced that agronomists should make an effort to discover crops which would grow in the sour, worn soils of the South with a minimum of treatment and expense. In 1919, therefore, he began a systematic study of acid-tolerant plants.

In plants grown at Arlington Farms, the Department's trial grounds at Rosslyn, Va., from seed of a new lespedeza brought from Korea, Dr. Pieters realized that he had found a crop sùited to southern soils. Accordingly, the seed was distributed to State experiment stations and to private co-operators ; and this plant is now used for hay, pasture, soil improvement, and erosion control as far west as Kansas and as far north as the lower Michigan line.

In 1923, Dr. Pieters added a perennial (*Lespedeza sericea*), which throve under adverse growing conditions, to the list of annual lespedezas, the use of which he was stimulating by his writing and by other means. The current popularity of lespedeza as a forage crop is attested by the fact that in 1938 some 17,000,000 pounds of seed were harvested—more than the combined seed crops of alfalfa, red clover, alsike clover, and timothy.

Dr. Pieters has written numerous bulletins, articles and pamphlets on lespedeza, and in 1934 published " The Little Book of Lespedeza ". He has prepared two digests of pasture literature ; and his " Green Manuring : Principles and Practice " presents the results of his researches in the field of soil improvement. As an agronomist with the Soil Conservation Service, he has studied the use of the lespedezas in the soil conservation programme, and is the author of several leaflets and articles on this subject, in addition to two bulletins which will appear in 1939.

The American Society of Agronomists has made Dr. Pieters one of its fellows, a distinction conferred each year upon two or three outstanding scientists in the agronomic field. Throughout the Southern United States, Chambers of Commerce and business men's clubs have honoured him for his services to farmers in their efforts to increase the productive capacity of their soils and to improve their economic condition.

Soil Conservation Service

The January, 1939 issue of *Soil Conservation* is devoted entirely to the engineering aspects of erosion control. The following are the titles of the separate articles.

T. B. Chambers. Engineering in soil and water conservation.
C. L. Hamilton. Farm drainageways and outlets.
H. G. Jepson. Graphic solution of channel dimensions by the Manning formula.
A. Carnes. Maintenance of the drainage-type terrace.
C. R. Enlow. Agronomic measures often require mechanical support.
H. T. Cory. Some engineering aspects of the water facilities programme.
W. W. McLaughlin. Irrigation and the conservation of the range.
E. R. Kinnear. Engineering planning in flood control.
G. E. Ryerson and William X. Hull. Equipment problems in conservation work.

Australia (94)

Agrostological Work in Australia

The Australian Wool Board has made a grant of £2,000 to the Council for Scientific and Industrial Research to enable it to extend its researches on the improvement and management of grassland, with special reference to the pastures in which the wool industry is particularly interested. The investigations proposed include :—

(1) surveys of representative areas of grassland in regions of summer and winter rainfall ;

(2) the extent to which grassland swards may be modified by such variations in management as are within the scope of station practice, or by the adoption of such suitable grasses and legumes as have been introduced from other countries by the Plant Introduction Section of C.S.I.R. :

(3) determination of seasonal variations in nutritive value of pastures, in co-operation with the Division of Animal Health and Nutrition :

(4) co-operative work with the Plant Genetics Section in extending the range of pasture species further inland, and with the Noxious Weeds Section in determining the extent to which appropriate methods of pasture management can effect weed control on pastoral properties.

Dr. J. G. Davies, formerly agrostologist of the Waite Agricultural Research Institute, has been appointed as senior agrostologist to initiate this programme. He is at present engaged on a survey of pasture problems in Western Australia, with a view to determining the best lines on which agrostological research may be developed in that State in co-operation with the State Department of Agriculture and the University School of Agriculture.

SEED EXCHANGE

The following section, containing lists of seeds offered in exchange by Botanic Gardens, and with notes regarding certain specific seed requirements, will be included in *Herb. Rev.* during 1939 as an experimental feature.—R.O.W.

SEEDS OFFERED IN EXCHANGE

Botanical Garden of the University of Cluj, Roumania

The seeds were collected in 1937 and (some only) in 1936. The asterisk indicates seeds of wild plants.

Leguminosae

**Anthyllis vulneraria* L.
**Astragalus asper* Jacq.
* *A. cicer* L.
A. echinus DC.
A. falcatus Lam.
A. glycyphylloides DC.
A. glycyphyllus L.
* *A. Péterfii* Jáv.
* *A. ponticus* Pall.
A. Römeri Simk.
A. sulcatus L.

Cicer arietinum L.
var. *nigrum*
var. *rotundum*

Desmodium canadense (L.) DC.
Dolichos Lablab L.
var. *atropurpureus*
var. *leucocarpus*

Galega officinalis L.
G. orientalis Lam.
Glycine hispida (Mnch.) Maxim.
var. black seeds
var. sem. *nigra*
var. *Tangora*

Indigofera decora Lindl.
I. Gerardiana R. Grah.

Lathyrus aphaca L.
L. clymenum L.
L. maritimus Bigel.
* *L. niger* (L.) Bernh.
L. nissolia L.
L. odoratus L.
L. sativus L.
L. silvester L.
var. *platyphyllus* (Retz) Aschers.
L. tingitanus L.
L. vernus (L.) Bernh.
Lens culinaris Medic.
Lespedeza bicolor Turcz.
Lotus albus Janka
L. corniculatus L.
L. ornithopodoides L.
L. siliquosus L.
L. tenuifolius (L.) Rchb.
L. tetragonolobus L.
Lupinus albus L.
L. Hartwegii Lindl.
L. polyphyllus Lindl.
L. succulentus Dougl.

Medicago lupulina L.
M. prostrata Jacq.
M. sativa L.
M. tribuloides Desr.
Melilotus albus Medic.
M. officinalis (L.) Medic.

Onobrychis caput galli (L.) Lam.
O. crista-galli (L.) Lam.
O. gracilis Bess.
O. viciaefolia Scop.
Ornithopus sativus Brot.

Phaseolus coccineus L. (*Ph. multiflorus* Willd.)
P. lunatus L.
P. vulgaris L.
var. *nanus* (L.) Aschers.
var. *zebrinus*
Pisum arvense L.
P. Jomardi Schrank
P. sativum L.

Trifolium arvense L.
* *T. campestre* Schreb.
* *T. fragiferum* L.
* *T. montanum* L.
* *T. ochroleucum* Huds.
T. pannonicum L.
T. pratense L.
T. repens L.
T. rubens L.
* *T. strepens* Cr.
Trigonella coerulea (L.) Ser.
T. foenum-graecum L.

Vicia cracca L.
* *V. dumetorum* L.
V. ervilia (L.) Willd.
V. faba L.
V. hirsuta (L.) Gray
V. pannonica Crantz
V. pisiformis L.
V. sativa L.
V. sepium L.
V. tenuifolia Roth
V. villosa Roth
Vigna sinensis (L.) Endl.

Gramineae

Aegilops bicornis Jaub. et Spach.
A. ovata L.
A. triaristata Willd.
A. ventricosa Tausch.
Agropyron cristatum (L.) R. et Sch.
A. elongatum (Host.) Beauv.

A. intermedium (Host.) Beauv.
A. junceum (L.) Beauv.
A. repens (L.) Beauv.
Agrostis alba L.
A. nebulosa Boiss. et Reut.
A. rupestris All.
Aira capillaris Host.
A. caryophyllea L.
Alopecurus aequalis Sobol.
A. pratensis L.
**Anthoxanthum odoratum* L.
Arrhenatherum elatius (L.) M. et K.
Asperella hystrix Humb.
Avena barbata Brot.
A. brevis Roth
A. fatua L.
A. nuda L.
A. orientalis Schreb.
var. *obtusata* All.
var. *tatarica*
var. *tristis* Alef.
A. satiza L.
A. barbata var. *aurea* Kcke.
var. *mutica* Alef.
var. *nigra* Krause
var. *trisperma* Schübl.

Avenastrum compressum (Heuff.) Deg.
* *A. decorum* (Janka) Deg.
A. planiculme (Schrad.) Jess.
A. pratense (L.) Jess.

Baldingera arundinacea (L.) Dum.
Bambusa aurea Sieb.
B. Hookeri A. et C. Riviere
Beckmannia eruciformis (L.) Host.
Bouteloua racemosa Lag.
Brachypodium distachyum (L.) R. et Sch.
B. pinnatum (L.) Beauv.
B. ponticum Velen.
B. silvaticum (Huds.) R. et Sch.
Briza maxima L.
* *B. media* L.
B. minor L.
Bromus arvensis L.
B. erectus Huds.
B. hordeaceus L.
B. inermis Leyss.
B. macrostachys Desf.
B. racemosus L.
* *B. ramosus* Huds.
B. rigidus Roth
B. secalinus L.
* *B. sterilis* L.
B. tectorum L.
var. *longipilus* Kümm. et Sendtn.
B. unioloides H.B. et K.

Calamagrostis arundinacea (L.) Roth
C. epigeios (L.) Roth
Cenchrus echinatus L.
C. tribuloides L.
Chloris ciliata Sw.
C. radiata Sw.
C. submutica H.B. et K.
C. truncata R. Br.
C. virgata Sw.
Chrysopogon gryllus (L.) Trin.
Coix lacryma Jobi L.
Cornucopiae cucullatum L.
Cynosurus cristatus L.
C. echinatus L.

Dactylis glomerata L.
**Danthonia calycina* (Vill.) Rchb.
**Deschampsia caespitosa* (L.) Beauv.
D. flexuosa (L.) Trin.
Desmazeria sicula Dum.

Echinochloa crus-galli (L.) R. et Sch.
Eleusine coracana Gaertn.
E. indica Gaertn.
E. oligostachya Link.
Elymus asper (Simk.) Hand. Maz.
E. canadensis L.
E. europaeus L.
E. sabulosus L.
Eragrostis pilosa (L.) Beauv.
Eriochloa villosa Kunth

Festuca arundinacea Schreb.
F. gigantea (L.) Vill.
F. pallens Host.
F. pratensis Huds.
F. rubra L.
* var. *fallax* Thuill.
F. sulcata (Hack.) Beck.
var. *hirsuta* Host.
var. *rupicola* Heuff.
F. valesiaca Schleich.

Haynaldia villosa (L.) Schur.
Hierochloa odorata (L.) Wahlng.
Holcus lanatus L.
Hordeum astrachanense Host.
H. bulbosum L.
H. distichon L.
var. *abyssinicum* Ser.
var. *nigrescens* Kcke.
var. *nudum* L.
var. *trifurcatum* Schübl.
H. hexastichon L.
H. jubatum L.
H. murinum L.
H. vulgare L.
var. *nigrum* Willd.
var. *pallidum* Ser.
var. *trifurcatum* Schübl.
H. zeocrithon L.

Koeleria Degeni Domin
K. gracilis Pers.
K. setacea DC.

Lagurus ovatus L.
Lamarckia aurea (L.) Moench
Lolium remotum Schrank.
L. temulentum L.

Melica altissima L.
var. *purpurea*
M. ciliata L.
* var. *flavescens* Schur.
M. Cupani Guss. var. *pannosa* Boiss.
* *M. transsilvanica* Schur.
**Molinia coerulea* (L.) Moench
var. *major* Roth
Monerma cylindricum (Willd.) Coss. et Dur.
Muehlenbergia mexicana (L.) Trin.
M. racemosa Britton. Stern et Pogg.

Oryza sativa L.
Oryzopsis holciformis (MB.) Richt
O. paradoxa Nutt.
O. virescens (Trin.) Beck.

Panicum californicum Benth.
P. capillare L.
P. esculentum A. Br.
P. miliaceum L. var. *album*.
var. *nigrum*
P. plicatum Lam.
Paspalum racemosum Lam.
Penicillaria spicata Willd.
Pennisetum Rupellii Steud.
Phalaris canariensis L.
P. minor Retz.
P. paradoxa L.
P. tuberosa L.
**Phleum ambiguum* Ten.
P. Michelii All.
P. phleoides (L.) Simk.
Phragmites vulgaris (Lam.) Crép.
Poa badensis Hke.
P. caesia Smith
P. nemoralis L.
P. pratensis L.
P. sterilis MB. ssp. *polonica* (A. et Gr.) Blocki

Polypogon monspeliensis (L.) Desf.
**Puccinellia transsilvanica* (Schur) Jáv.

**Sclerochloa dura* (L.) Beauv.
Secale cereale L. var. *nivalis*
S. montanum Guss.
Sesleria argentea Savi
S. coerulea (L.) Ard.
S. Heufleriana Schur
* *S. rigida* Heuff.
Setaria glauca (L.) R. et Sch.
S. italica (L.) R. et Sch.
S. macrochaeta Spreng.
S. verticillata (L.) R. et Schult.
S. viridis (L.) R. et Sch.
Sorghum halepense (L.) Pers.
S. vulgare Pers.
var. *aethiopica* Kcke.
var. *saccharatum* (L.) Pers.
var. *technicum* (Koern.) Jav.
**Stipa capillata* L.
* *S. pulcherrima* C. Koch

Tragus racemosus (L.) All.
Tricholaena rosea Nees
Tripsacum dactyloides L.
Trisetum flavescens (L.) R. et. Sch.
Triticum aestivum L.
var. *aristatum* Schübl.
T. compactum Host. var. *clavatum* Alef.
var. *icterinum* Alef.
T. dicoccum Schrk.
var. *rufum* Schübl.
T. durum Desf. var. *leucomelon* Alef.
var. *obscurum* Kcke.
T. monococcum L.
T. polonicum L.
var. *oblongum*
T. spelta L.
var. *coeruleum* Alef.
T. turgidum L.

Uniola latifolia L.

Vulpia myuros (I.) Gmel.

Zea Mays L.
var. *cryptosperma* Bonaf.
var. *dentiformis* Kcke.
var. *vulgaris* Kcke. *cinquantino* fr. *rubra*

Botanical Garden of the University of Cluj, Roumania (Supplementary List)

Alopecurus nigricans Hornem.
Digitaria sanguinalis (L.) Scop.
Koeleria eriostachya Panc.
K. gracilis Pers.

* * *

Stipa capillata L.

* * *

Danthonia calycina (*Vill.*) Rchb.
Phleum ambiguum Ten.
Poa badensis Hke.
Stipa stenophylla Czern.

* * *

Andropogon ischaemum L.
Bromus ramosus Huds.
Cynosurus cristatus L.
Festuca gigantea (L). Vill.
Phleum pratense L.
Trifolium campestre Schreb.
T. montanum L.
T. strepens Cr.

* * *

Bromus squarrosus L.

* * *

Brachypodium pinnatum (L.)
Bromus squarrosus L.
Stipa stenophylla Czern.

* * *

Calamagrostis arundinacea (L.)
Deschampsia flexuosa (L.) Trin.

* * *

Brachypodium silvaticum (Huds.) R. et Sch.
Briza media L.

* * *

Agropyron cristatum (L.) R. et Sch.
Astragalus cicer L.
Atriplex tataricum L.
Bromus commutatus Schrad.
B. squarrosus L.
B. tectorum L.
Calamagrostis epigeios (L.) Roth.
Cynodon dactylon (L.) Pers.
Eragrostis minor Host.
Medicago sativa L.
Melilotus officinalis (L.) Medic.
Onobrychis viciaefolia Scop.
Poa nemoralis L.
P. pratensis L.
Trifolium arvense L.
T. pratense L.
Koeleria gracilis Pers.

State Botanic Garden, Brussels

Apply direct to: —Direction du Jardin Botanique de l'État, 236, rue Royale, Bruxelles, Belgique; or through the Deputy Director of this Bureau.

Aegilops ovata L.
A. speltoides
Agropyrum caninum
A. pycnanthum
Agrostis alba L. var. *stolonifera*
A. nebulosa
A. rupestris
A. vulgaris
Alopecurus agrestis
A. arundinaceus
A. geniculatus
A. pratensis
A. ventricosus
Andropogon ischaemum
A. Sorghum
Anthoxanthum odoratum
Anthyllis tetraphylla
Arrhenatherum elatius
Astragalus Cicer
A. galegiformis
A. gummifer
A. glycyphyllos
A. Robbinsii
A. Tragacantha
Atriplex hortensis
A. rosea
A. sibirica
Avena fatua
A. orientalis
A. sativa
A. sterilis
A. strigosa

Brassica arborea
B. campestris
B. nigra
B. oleracea
B. Rapa
B. sinapistrum
Briza geniculata
B. maxima
B. media
B. minor
Bromus arvensis
B. carinatus
B. commutatus
B. erectus
B. macrostachys
B. madritensis
B. maximus
B. secalinus
B. sterilis

Calamagrostis epigeios
Cenchrus echinatus
C. viridis
Cynodon dactylon
Cynosurus cristatus
C. echinatus

Dactylis glomerata
Demazeria sicula
Deschampsia caespitosa
D. flexuosa
Desmodium canadense

Eleusine coracana
Elymus arenarius
Eragrostis pilosa

Festuca geniculata
F. heterophylla
F. ovina
F. pratensis
F. pseudovina
F. rubra

Glyceria distans
G. nervata
Glycine hispida
Glycyrrhiza glabra

Helianthus annuus
H. strumosus
Holcus lanatus
H. mollis
Hordeum bulbosum
H. hexastichon
H. maritimum
H. murinum
H. sativum
H. vulgare

Koeleria cristata
K. phleoides
K. setacea

Lespedeza macrocarpa
Lotus corniculatus
L. ornithopodioides
L. uliginosus
Lupinus albus
L. Cruikshanksii
L. Douglasii
L. elegans
L. insignis
L. luteus
L. ornatus
L. polyphyllus
L. perennis
L. subcarnosus

Medicago apiculata
M. falcata
M. lupulina
M. minima
M. orbicularis
M. sativa
M. tuberculata
Melica altissima
M. ciliata
M. uniflora
Melilotus alba
M. officinalis

Nardus stricta

Onobrychis crista-galli
O. montana
Ornithopus sativus

Panicum capillare
P. Crus-galli
P. filiforme
P. miliaceum
P. virgatum
Paspalum vaginatum
Pennisetum Ruppellii
Phalaris canariensis
P. minor
Phaseolus caffer
P. glaber
P. lunatus
P. multiflorus
P. tuberosus
P. vulgaris
P. Wightianus
Phleum Boehmeri
P. pratense
Poa compressa
P. lanigera
P. nemoralis
P. pratensis
P. serotina
P. trivialis

Secale cereale
Setaria glauca
S. italica
S. verticillata
S. viridis
Stipa calamagrostis
S. gigantea
S. splendens

Trifolium alpestre
T. arvense
T. fragiferum
T. incarnatum
T. montanum
T. repens
Trigonella coerulea
T. foenum-graecum
Tripsacum dactyloides
Trisetum flavescens
T. macrotrichum
Triticum dicoccum
T. monococcum
T. polonicum
T. sativum
T. Spelta
T. turgidum

Vicia amphicarpa
V. cracca
V. ervilia
V. faba
V. lutea
V. picta
V. sativa
V. sepium

Zea mays

Faculty of Agriculture, Institute for Applied Botany, Sofia Univ., Bulgaria
1938 List

Agropyrum cristatum
A. glaucum
A. villosum
Agrostis canina
A. vulgaris
Alopecurus pratensis
Anthyllis Barba-Jovis
Arrhenatherum avenaceum
A. elatius
Astragalus armeniacus
A. glycyphyllos
Atriplex hortensis
Avena brevis
A. fatua
A. montana
A. orientalis
A. sterilis
A. strigosa

Brachypodium pinnatum
Briza maxima
B. media
B. minor
Bromus maximus
B. transsylvanicus

Calamagrostis arundinacea

Deschampsia caespitosa
D. flexuosa

Festuca duriuscula
F. elatior
F. glauca
F. Halleri
F. heterophylla
F. ovina
F. ovina v. *glauca*
F. picta
F. rubra
F. valesiaca
F. violacea

Glycyrriza glabra

Holcus lanatus
H. mollis

Koeleria phleoides

Lathyrus cicera
L. cyaneuss
L. heterophyllus
L. inermis
L. odoratus
L. pisiformis
L. pratensis
L. silvester
L. tuberosus
Lotus ornithopodoides
Lupinus polyphyllus

Medicago falcata
M. sativa
Melilotus officinalis
M. sagetalis
Molinia coerulea

Onobrychis lasiostachya
O. viciaefolium

Phalaris arundinacea
Phleum Boehmeri
P. Michelii
P. pratense
P. pratense v. *nodosa*
Poa alpina
P. compressa
P. nemoralis
P. trivalis
P. violaceae

Stipa gigantea
S. pennata

Trifolium alpestre
T. elegans
T. heldreichianum
T. maritimum
T. montanum
T. panormitanum
T. pratense
Torilis Anthriscus
Trisetum flavescens

Vicia orobus

REQUESTS FOR SEED

A number of requests for samples of seed of various herbage and forage plants have been received at the Bureau in recent months. They are reproduced here for general information, and in the hope that readers who may be able to help will communicate with the Deputy Director.

Dr. T. M. Stevenson, Dominion Agrostologist, Central Experimental Farm, Ottawa, Canada. (November 25, 1938).

> Small samples of sunflower seed (*Helianthus annuus*) representing selections of various types. Particular request for Turkish strains.

Director of Agriculture, Maseru, Basutoland. (January 24, 1939).

> The Department wishes to introduce certain pasture plants in their mountain area. The rainfall is about 30 in., fairly well distributed throughout the year, as part of it falls as snow in the otherwise dry winter months. The soils are good and the temperature is cool. What are particularly required are aggressive species, capable of establishing themselves without preparation of the soil, apart from burning and treading of stock, and withstanding close grazing of sheep, so as to provide protection to the friable soils on the steep mountain slopes. Among the species they mention are *Lolium perenne*, *Dactylis glomerata*, *Agrostis tenuis*, *Trifolium repens*, *Poa pratensis*, *Holcus lanatus*, *Bromus unioloides*, *B. inermis*, *Agropyron repens*, *Poa nemoralis*, *Agropyron* sp. (Western wheatgrass), but any others which may be considered suitable will be very welcome. They require samples sufficient to give a succession of seedings in small plot trials.

J. L. Fyfe, Plant Breeding Institute, School of Agriculture, Cambridge. (February 21, 1939)

> Seed for genetical studies, including experiments with colchicine.
> *Lucerne* : Grimm, Ultuna, Marlborough, Hungarian, Provence and English.
> *Soybean* : Varieties.
> *Sainfoin* : Any species of *Onobrychis*, particularly diploids.

Director, Grasslands Division, Plant Research Bureau, Palmerston North, New Zealand. (January 24, 1939) :

> Seeds of subterranean clover (*Trifolium subterraneum*) from its original habitats (stated to be Southern Europe, Western Asia as far East as India, and Northern Africa.)

Botanical Institute and Gardens, Academy of Sciences, Leningrad, 22, Pessotchnaia 2, U.S.S.R. (January 31, 1939).

> A proposal has been made and correspondence is now in progress relative to an exchange of seed of drought-resistant and salt-tolerant forage plants (grasses or shrubs) capable of thriving under desert conditions without any kind of artificial watering.

The Director of the Institute (Dr. B. Šiškin) requests 30-100 grm. of seed of such plants, and offers in exchange seed of the following species: *Agropyron sibiricum*, *A. desertorum*, *A. trichophorum*, *Aeluropus littoralis*, *Eurotia ceratoides*, *Glycyrrhiza aspera*, *Ferula Schair*, *F. karatavica*, *F. assefoetida*, *Cousinia trifolia*. During 1939 a collection will be made in U.S.S.R. of seed of a great number of desert and semi-desert plants belonging to the genera: *Medicago*, *Trigonella*, *Astragalus*, *Agropyrum*, *Poa*, *Bromus*, *Kochia*, *Salsola*, *Atriplex*, *Rheum*, *Polygonum*, *Crambe*, *Isatis*, *Ferula*, *Prangos*, *Convolvulus*, *Artemisia*. These will be offered in exchange. Any person or institute interested in participating in this exchange is requested to communicate with the Deputy Director of this Bureau as soon as possible.

J. M. Vincent, School of Agriculture, University of Sidney, New South Wales, Australia. (February 16, 1939.)

"It has become evident how little is known of host/organism specialization in the matter of symbiotic nitrogen fixation and how the problem is being affected by the heterogeneity of the usual lucerne population. I am hoping then to be able to check *pure line strains* of lucerne against a particular strain of organism and organisms against a pure line lucerne."

Mr. Vincent would like to have small samples of any pure line strain of lucerne until he has been able to develop pure lines of local strains.

PRINTED BY THE CAMBRIAN NEWS (ABERYSTWYTH), LTD.—650/3/39.